FLOATING TRANSFER STATIONS

A LOGISTICS OPTION FOR EXPORTING COAL

FROM THE WEST COAST

A dissertation

submitted in partial fulfilment

of the requirements for the degree

of Master of Professional Studies

at

Lincoln University

by

Sean Bolt

Lincoln University

2006

Acknowledgements

I would like to acknowledge the contribution of the following people without whose help I could not have completed this study.

To my supervisor, Professor Chris Kissling, thank you for your guidance and more importantly your patience.

To David Stapleton, manager of the Port of Greymouth, a thank you for providing the graphs on West Coast coal production and the historical port information.

To Tony King, from Option One, for his input in to issues on sensitivity analysis and providing the Road Transport Association Truck costing model.

To Tony Pidgeon, from Beca's, for providing confirmation of the assumptions on barging trip times.

To Captain David Barnes for sharing his considerable experience on maritime issues with bar harbours and West Coast conditions.

To Captain Peter Dunlop, and my old school colleague Ian Coombridge from Sea-Tow, for the information on their proposed transhipment facility at Golden Bay.

Finally a huge thank you to my family, Kate, Madeleine and Gabrielle who have had to make significant sacrifices enabling me to complete this considerable journey.

Abstract of a dissertation submitted in partial fulfilment of the requirements for the Degree of M.Prof.Studs.

FLOATING TRANSFER STATIONS

A LOGISTICS OPTION FOR EXPORTING COAL FROM THE WEST COAST

By Sean Bolt

This dissertation looks at the issues of exporting coal from the West Coast. On the basis that the Midland rail line has capacity constraints, other transport options are explored including likely costs. A literature review shows serious issues around the existing rail connection that make it imperative that other economically viable transport options are established.

Possible alternatives to rail include road, jetty, deep sea port, mono buoy and barging to a transhipment port. The objective of this dissertation is to show that of the various options, transhipment by barging to a floating transfer station (FTS) appears to offer a viable economic alternative.

Operational issues and the advantages and disadvantages of each option however, are discussed. The costs of the differing options are also summarised.

Issues around the supply, demand and price of coal are also explored with the assumption that, ceteris paribus, the price for coking coal will remain at, or above, a price that will sustain investment in an alternative transport chain.

The announcement by Pike River Coal Company (PRCC) of its intention to barge coal to Port Taranaki at New Plymouth after an exhaustive two year investigation into transport options lends weight to the advantages of using the Port of Greymouth and the barging/transhipment option as opposed to the existing rail route. However, initial work carried out by the author lends weight to the floating transfer option, though there is some sensitivity to exchange rate and volume variations.

Contents

Keywords

Barging	Capesize	Coal	FTS
Golden Bay	Greymouth	Midland Line	Offshore Jetty
Panamax	Port Taranaki	PRCC	Shakespeare Bay
Solid Energy	Transhipment	West Coast	Westport

Figures

Tables

Chapter One

Introduction

The issues surrounding the transport of coal off the West Coast first came to the attention of the author in 1994 when he was Harbour Master at Westport.

Problems surrounding large shipments of coal were coming to the fore and Coal Corp (forerunner to Solid Energy) was exploring the possibility of building a large offshore jetty north of Westport for the export of Stockton coal.

The jetty never eventuated and over the next decade there were continued industry murmurings that despite the coal transport route remaining on rail, the rail link between the West Coast and the Port of Lyttelton (known as the Midland Line) was deteriorating and there were serious issues, if coal production were to increase, in transporting the extra coal over the Midland Line. The author was appointed CEO of Port Marlborough in 2003 and in that capacity had discussions both with Solid Energy and Pike River Coal Company (PRCC) about the possibility of using Port Marlborough's deepwater port (Shakespeare Bay) for the transhipment of coal from the West Coast. The high capital cost of setting up appropriate facilities and the risks involved (essentially the facility is exposed to the same risk factor as a mine) got the author thinking of other possible transportation options besides Port Marlborough and indeed, besides the present method of railing coal to the Port of Lyttelton. Continued speculation within the industry and in the media about the poor state of the Midland Line was confirmed by the Kellog Brown & Root Pty Ltd report commissioned by the Land Transport Safety Authority (LTSA) which stated, inter alia, in June 2004....

"The Coal route is currently fit for tonnage it is carrying. However, the increase in axle load and overall tonnage over recent years, the present maintenance philosophy, and a lack of technical resources and finance make it unlikely that it can remain fit for purpose beyond the immediate future (say, two years). There is a backlog of maintenance and renewal work and there is a proposal to double the tonnage of coal which is hauled on the route. Even at present freight level, significant expenditure is required in the short to

medium term to keep the line operating safely. If the coal tonnage increases, there will need to be corresponding increase in expenditure."

Kellog Brown & Root Pty Ltd. (2004, June 22.) *Review of the South Island Rail Coal route.* Retrieved 7th July, 2006,

from http:// www.landtransport.govt.nz/rail/coal- route.pdf.

With renewed interest in West Coast Coal (coking coal prices were increasing markedly), the potential for increased production and increased transport capacity showed there were risks in the present logistics chain. Put simply here was a resource with increasing world demand and reasonably long term supply (setting aside mining risks) that may not be able to take advantage of the opportunity of being exported because of transport constraints. There had to be an economic alternative to the rail option that would increase the transport capacity, provide a more flexible transport operation than rail alone and give exporters an alternative transport option. In addition, the challenge would be to minimise the stranded capital involved with constructing port capacity required to tranship coal as mining ventures are inherently more risky than the Port Industry. The Cost of Capital Report put out by Price Waterhouse Coopers (June 2004) lists the port sector Weighted Average Cost of Capital (WACC) 8.8% as opposed to Mining at 9.8%.

Price Waterhouse Coopers. (2004, June 30th). *The Cost of Capital Report.*

Retrieved July7th2006, from

www.pwcglobal.com/nzenginssol/publications/Cost_of_Capital_jun_04.pdf

Further investigation of media reports showed reported issues surrounding the state of the Midland Line, disregarding the possibility of having to handle increased tonnages. This was apparent when Solid Energy increased output from 2.1 million tonnes to 2.4 million tonnes and had to truck coal from Westport to Reefton because of, reportedly, *capacity constraints* on the rail line in the Buller Gorge.

Madgwick, P. (2004, July 10th). *Extra Coal Train*, Christchurch Press.

Transhipment alternatives were also reported in the same article:

"With restraints on the Midland rail line between the West Coast and Lyttelton, Solid Energy has also announced plans to build three colliers to ship coal out of Greymouth and Westport." Madgwick, P. (2004, July 10th).Extra Coal Train, Christchurch Press.

General discussion with Professor C. Kissling at Lincoln University helped crystallise the author's thoughts on these issues. It was also apparent there was not a lot of literature, certainly in the New Zealand context, about these transport issues.

This became the catalyst for the author to investigate the possibilities of using a Floating Transfer Station to export West Coast coal (as opposed to barging to another port).

Unfortunately there is very little international literature about the use of Floating Transfer Stations, either from an economic, operational or policy point of view. There is no literature that the author could find in the academic world on this subject.

Chapter Two

Aim of Dissertation

The aim of the dissertation is to identify alternative transport options to rail for the export of coal off the West Coast and to test whether a floating transfer station (FTS) is a viable economic alternative to the other transport options. It is not a technical treatise on the engineering issues surrounding those transport options, nor is it an in-depth analysis of the operational issues with transhipment options.

With the announcement of the Pike River Coal Mine, (Madgwick, P. (2004, November 13th).King Coal Rocks, Christchurch Press); indications are that the output from this mine will be in the order of between 1 million to 1.3 million tonnes per annum.
The production from this mine will be used as the basis for the proposal that coal can be economically barged off the coast to a FTS as opposed to the other transport options.

The assumption is that if barging PRCC coal from Greymouth is viable then it will be viable for coal from either, other coal mines in the Greymouth area, or, from mines in the Westport area. The caveat for both of these possibilities is that output from the mine is at most two or three types of coal. This is important, because unless the coal is blended into its final export form prior to barging, there are constraints at the FTS to how many blends it can handle. Ideally one grade of coal is preferable but the FTS can adequately handle two grades (blends). As an example, the PRCC mine will produce two types of coking coal, predominantly determined by sulphur content - 1.2% by volume and 1.9% by volume.

"Pike River development will focus solely on the Brunner coal, which comprises only one thick, continuous coal seam.....it is a high grade bitumous coal (hard bright) coal, with no plies or claystone partings within the seam. The hard coking coal is low in ash (averaging-1%), has very high fluidity, and will be produced in two grades; 1.2% sulphur and 1.9% sulphur."

McDouall Stuart. (2005, November 24th). *Equity research NZ Oil and Gas Ltd.*

Retrieved July 22, 2006, from

http:/www.nzog.net/Investorsection/NZOG/20Report%2024Nov05.pdf.

The reason it is assumed that if a FTS is a financially viable alternative to using the rail/Port of Lyttelton alternative for coal shipped from Greymouth then it is highly likely to work at Westport, is that the distance to rail or truck coal from the Westport area to Lyttelton (existing method of exporting coal) is much further than Greymouth, (therefore there will be greater unit costs with this land transport mode from Westport) and the barging distance from Westport to a FTS is less than from Greymouth by about 45 nautical miles, hence barging costs will probably be cheaper.

The dissertation will show that not only are floating transfer stations a viable operational alternative, but by financially modelling each transport alternative and comparing the costs it will be shown that a FTS is potentially less costly than other transport alternatives. The dissertation is not trying to establish the environmentally best option, or in some way to balance environmental, social and economic objectives, but to show that the use of a FTS is a viable economic alternative to the existing transport option (rail) and to other potential transport options.

This study is important for the following reasons.

- It is strategically important that there is an alternative option to get coal off the West Coast because the Midland line is vulnerable to earthquake, slips, poor maintenance, and capacity constraints.
- Coal exporters are open to monopoly pricing of rail or port services.
- Solid Energy has a monopoly on the Midland line and the coal handling facilities at the Port of Lyttelton. Any new entrant must have a viable transport alternative.
- If the Midland rail line is running at capacity, any stoppages or delays at Lyttelton or on the track mean no ability to catch up tonnage or meet sudden peak demands.
- A least cost alternative is identified.

The proposal is that coal will be barged from Greymouth to a floating transfer station anchored in Golden Bay and then transferred to an export bulk carrier as an economic alternative to other methods of exporting coal (road or rail to the port of Lyttelton, building an off-shore jetty, building a Port, using a mono buoy or barging to another port).

Risks associated with the supply of coal may be mitigated by the existence of alternate cargoes (either return cargoes or supplementary cargoes). Alternate cargoes have not been explored, nor have they been factored in to calculations for determining capacity requirements or alternative revenue streams.

Chapter Three

Research Methodology

Unfortunately there is little information about the use of Floating Transfer Stations as a method of handling coal in the New Zealand context. Worldwide, there is no academic literature on using such a transport mode. There is little financial information on the costs involved of running road, rail and sea transport modes in the transport of coal off the West Coast. The owners of such information protect it vigorously because of its commercial value in competing with other transport modes.

The constraints both physical and commercial on the Midland line (rail link to Lyttelton) are gleaned from mainly newspaper articles - simply because neither Solid Energy nor Tranz Rail are likely to admit the issues identified in the LTSA report let alone identify categorically the costs involved in improving deficiencies or increasing capacity.

The present value of the rail contract is commercially sensitive to Solid Energy and Tranz Rail - as is the costs of using Lyttelton Port.

Whilst from an operational viewpoint it is relatively straight forward to show that a FTS can be used as an alternative transport mode, it is a pointless exercise unless it can be shown to be financially viable. To do this required a ground up approach using what information is available, either directly, where it has been freely given, or by using publicly available information (web sites) and where verifiable, by the author's knowledge of costs of port operations. The author has spent 30 years in the maritime environment, holds a Masters Foreign Going (Class 1) certificate, has been Harbour Master at Westport, a ships officer, Tug Master, Hydrographer, Dredge Master, Harbour Pilot and Chief Executive of Port Marlborough. This combined experience gives the author a reasonable depth of knowledge of the operational issues (and first hand exposure to some of the financial costs) that arise in this dissertation. The financial basis for costing alternative transport options are to factor in fixed and variable costs using a fixed equity return on capex. A more vigorous approach would be to calculate the Weighted Average Cost of Capital (WACC) for each of the investing parties and then calculate whether the Net Present Value of the option was positive using the WACC as a hurdle rate. That was not done on the basis that establishing the components of the WACC for each potential investor (i.e. Port Company, Rail operator, Trucking contractor, Barging operator, Infrastructure investor) is beyond the scope of this dissertation.

Chapter Four

Literature Review

The logic of the order of presentation of the material quoted in the literature review is to show that:

a) there are substantial coal reserves on the West Coast
b) Solid Energy is expanding coal production from Spring Creek.
c) PRCC are commencing coal production in the Grey area.
d) Issues with the Midland line possibly prevent rail being able to meet required transport capacity.

Coal reserves on the West Coast of the South Island are put at approximately 983 million tonnes and of this; 343 million tonnes are thought to be recoverable.

Coal Fact sheets retrieved June 10th, 2005
from www.crownminerals.govt.nz/coal/facts/resource.

Solid Energy export coal production from the West Coast of the South Island is set to expand over the next 5 years from its present output of 2.4 million tonnes to between 3.5 and 4 million tonnes per annum.

De Lacy, Hugh (2004).Elder: Co-operation option for Coast Coal transport.
Page 14"Contractor"; NZ Quarrying and Mining magazine, March: 2004.

Pike River Coal Company now has consent to begin mining operations at Pike River with volumes forecast to reach 1.2 million tonnes per annum.

Madgwick, P. (2004, May 4th). Coalmine progress exciting, *Christchurch Press*.

It would appear that world demand for coal (coking and thermal) is increasing with the emergence of China and India as major economic powers. This is borne out by the rapidly increasing price.

"Analysts keep increasing their estimates for prices as demand stays strong and supply can't keep up. It's a sellers market and that situation is unlikely to change any time soon says Wilson HTM analyst Keith Williams....The price of coking coal used to make steel

could rise to over US$100 per tonne, up from US$ 57 a tonne this year and US $46 in 2003-04. Williams, Keith (2004, November 10th) *Dominion Post.*

Presently the majority of West Coast export coal is railed to Lyttelton on the Midland line and exported through the Port of Lyttelton. Anecdotal evidence that the rail line is in a poor state of repair and will require significant investment just to maintain its present capacity was confirmed by a report commissioned by the LTSA referred in the introduction.

Solid Energy has, according to media reports, negotiated with Toll NZ Ltd extended use of the rail system with increased volumes of coal.

"Toll has struck a 13 year transport deal that will allow Solid Energy to move up to 3.8 million tonnes of West Coast coal a year from 2007-08. The deal is expected to result in 2.4 million tonnes of coal moved this year, and up to 2.7 million tonnes in 2005-06. The increase in tonnage will see eight trains plying the route between West Coast and Lyttelton, an increase of one per day." (Dominion Post 29:10:2004)

This was confirmed publicly by Toll Rail in an article in the Shipping Gazette where their General Manager Bulk Cargo was quoted:

Mr Muir says *"up to 3.8 million tonnes carrying capacity will be achieved in the middle of next year when Ontrack completes loop extension work and Toll Rail introduces an additional 66 CE wagons. This will consequently enable Toll Rail to introduce an eighth daily train on its 24/7 service to meet Solid Energy's forecast growth"*

Record Solid Energy Volumes. (2006, April 29th). *The Shipping Gazette*, p.19.

Despite recent agreement between the new owners of Tranz Rail (Toll NZ Ltd) and the owner of the rail track (New Zealand Government trading as On Track) to each invest $25 million (reported in both the Dominion Post 26:7:2004 and Christchurch Press 17:8:2004) to upgrade the infrastructure, this will not be sufficient to meet potential coal production. In fact Solid Energy claim in excess of $70 million is required just to cover deferred maintenance (*Christchurch Press* 25:8:2004).

The ex mayor of Westport, Pat O'Dea, claimed the amount the Government had earmarked was *"enough for a patch-up job and will not ensure long term viability"*

Coal Line Cash Worry. (2004, 26th July). *Dominion Post.*

It seems a question mark hangs not just over the line's capacity but also its capability given its state of disrepair. Given the uncertainty over the Midland line it would seem there will be a shortfall of transport capacity for the intended coal production of between 1.2 and 1.7 million tonnes per annum.

Existing producer Francis Mining claims that Solid Energy's monopoly of the Midland rail line coal carrying capacity had caused Francis Mining to have to barge a million tonnes of coal over seven years to Port Kembla from Greymouth. Miner goes for barge alternative. (2004, November 3rd). *Christchurch Press.*

If indeed there are capacity constraints, even if the issues of the poor state of disrepair are addressed, then an alternative, economically viable, transport alternative needs to be found if increasing coal production is to be exported off the West Coast.

Three possible ways of getting large shipments of coal off the West Coast would be to build,

1) a deep sea port,
2) a single point mooring system or
3) a deep sea jetty.

The first option was first mooted at the turn of the 20th century by the Harbour Boards of both Westport and Greymouth but discounted due to lack of a suitable site and cost. The second option (similar to the Taharoa iron sand export facility) is a possibility but it differs from the iron sand operation in that at Taharoa, water from the sand/water mix that is pumped out to the ship moored to the offshore buoy is pumped (discharged) directly into the sea. The ship plying the trade goes back and forth between the same ports and is specially constructed for purpose. Given that the coal will be going to different countries and ports, the cost of a large fleet of specialised coal carriers capable of tying up to a single point mooring would, in all likelihood, introduce huge shipping costs. There are environmental issues, weather issues, and the double problem of the coal slurry having to be de-watered and the cost of piping coal-contaminated water back to shore for treatment.

The ex Harbour Master of Westport, Captain D Barnes states; *"Slurried cargoes to a single point mooring have also been mooted and certainly solve the problem of safely mooring a vessel but presents problems. The vessel has to be dewatered either by pumping slurry water overboard or returned ashore for settling. Obviously pumping overboard vast amounts of black liquid is unacceptable. To return it to shore would require considerable power and pumping capacity but more importantly huge settling ponds as the coal fines are just not responsive to separation even in the long term"* (Captain D Barnes, personal communication 22 July 2006).

The third option has had considerable interest and in December 1997 Solid Energy's resource consents to build a coal export jetty, wharf and barge facility at Granity were granted subject to conditions. "The granting of these 23 consents puts the company in a position to decide whether to proceed and build the 2.3 km, $170 million facility"
Coal Jetty Consents Granted. (1998). *New Zealand Mining Volume* 23, page 7

By 2003 the cost estimates of the Jetty had risen to $219 million as stated in the KPMG Buller Coal Jetty review done for Solid Energy and the Buller District Council (report sighted by author). In addition to the cost, there are considerable operational difficulties to overcome. Again, quoting Captain D Barnes:

"In the mid 1990's a coal export jetty reaching out to sea 2 Kms from Birchfield in Buller Bay was propagated. Considerable sums of money went into a substantial feasibility study. Considerable commercial positioning could be said to be involved in the process of obtaining consent for this project which was said to be feasible. Whatever modern calculations and computer programs can be applied to the problem with ships in an open seaway there will always be surge problems. The abruptness of the onset of adverse weather in the area may well preclude the safe sailing of any vessel alongside and particularly should she need the assistance of tugs. The problem of stationing tugs in the vicinity of such a jetty was amply illustrated in the disaster at Whiddy Island in Bantry Bay Ireland on 8th January 1970. The tugs had to be berthed in the lee of the Island and not off the berth as was originally proposed as feasible. That would be the likely scenario at Westport or off Rapahoe. Voith Tugs with the required power and a draft of around 3.5 metres are possible but in a building swell would be unable to exit the ports thus leaving any ship on the sea berth unable to sail without the likelihood of significant, even disastrous damage" (Captain D Barnes, personal communication 22 July 2006).

Seatow, a tug and barge company in New Zealand are themselves looking at alternative transport options. They favour the use of a coal transhipment facility in Golden Bay using large barges to stockpile coal. They have prepared a 103 page report "Assessment of Environmental Effects" to enable them to obtain Resource Consent to operate such a facility. That report states, inter alia: "In recent years, a number of options have been considered for the development of a new coal exporting facility on the West Coast. Investigations have been undertaken into a slurry pipeline loading facility at Granity and the development of a new port at Port Elizabeth, Rapahoe (about $7 million was spent on studies into the viability of the latter option). In the final analysis, none of these options has been taken up primarily due to weather-related constraints on the number of days that such a facility could be safely operated and the likely high cost of maintenance in such a high wave energy environment. The prevailing weather is also the reason why transhipment at sea off the West Coast is not an option":

Sea Terminals Ltd (2006) Coal Trans-Shipment Facility Golden Bay, New Zealand; Assessment of Environmental Effects, page 21.

An alternative method of exporting this production is the use of barges and/or small ships to take the coal out of Greymouth and/or Westport to an intermediate site for stockpiling before onwards shipment in export vessels. Solid Energy themselves have publicly discussed the idea of barging coal in addition to using rail to export coal.

"Solid Energy (SE) is looking seriously at the building 120-130 metre ships capable of lifting 10,000 -12,000 tonnes at a cost of $10-$12 million each to back up the rail transport route. Solid Energy claims it had *"lost $200 million in coal exports through former national rail operator Tranz Rail's neglect of its networks*."

Don Elder, Solid Energy CEO, quoted in the *Dominion Post* 15:02:2005.

Prior to the Midland line being completed in 1923 (The Reefton-Westport line was completed 1943) millions of tonnes of coal were exported through the Ports of Westport and Greymouth. Greymouth had exported 19 million tonnes of coal between 1864 and 2005, peaking at 467,520 tonnes in 1916: (Port of Greymouth Management Ltd-historical shipping data) so it is not an unknown mode of transport.

However there are constraints at both of these harbours. In colloquial terms they are known as "bar" harbours as they have at their entrance a sand/shingle bar caused by the interaction of an out flowing river, currents and swell action. Changing depths over the bar, relative shallow depths, currents and the physical shape of the rivers confine vessel size and draft to maximum loads of approximately 10,000 tonnes. Again to take advantage of Captain Barnes's decade of experience, *"The present constraining dimensions of ship types vessels to safely enter the Ports of Greymouth and Westport with an under keel clearance of 1 metre would appear to be around 120 metres length and 25 metres beam...the barge "Union Bulk 1" averaged around 10,000 metric tonnes on a length of 133 metres, 24 metres beam and a draft of approximately 5 metres"* (Captain D Barnes, personal communication 22 July 2006).

Thus coal is required to be taken in relatively small loads (6,000 to 10,000 tonne loads) to a transhipment point to be stockpiled for subsequent reloading on to larger vessels. The transhipment point could be another port capable of handling larger export loads or a floating transfer station (FTS).

Chapter Five

Floating Transfer Stations as a concept

A floating transfer station (FTS) is essentially a floating barge or floating converted bulk carrier which is anchored to the seabed and is capable of storing bulk commodities.

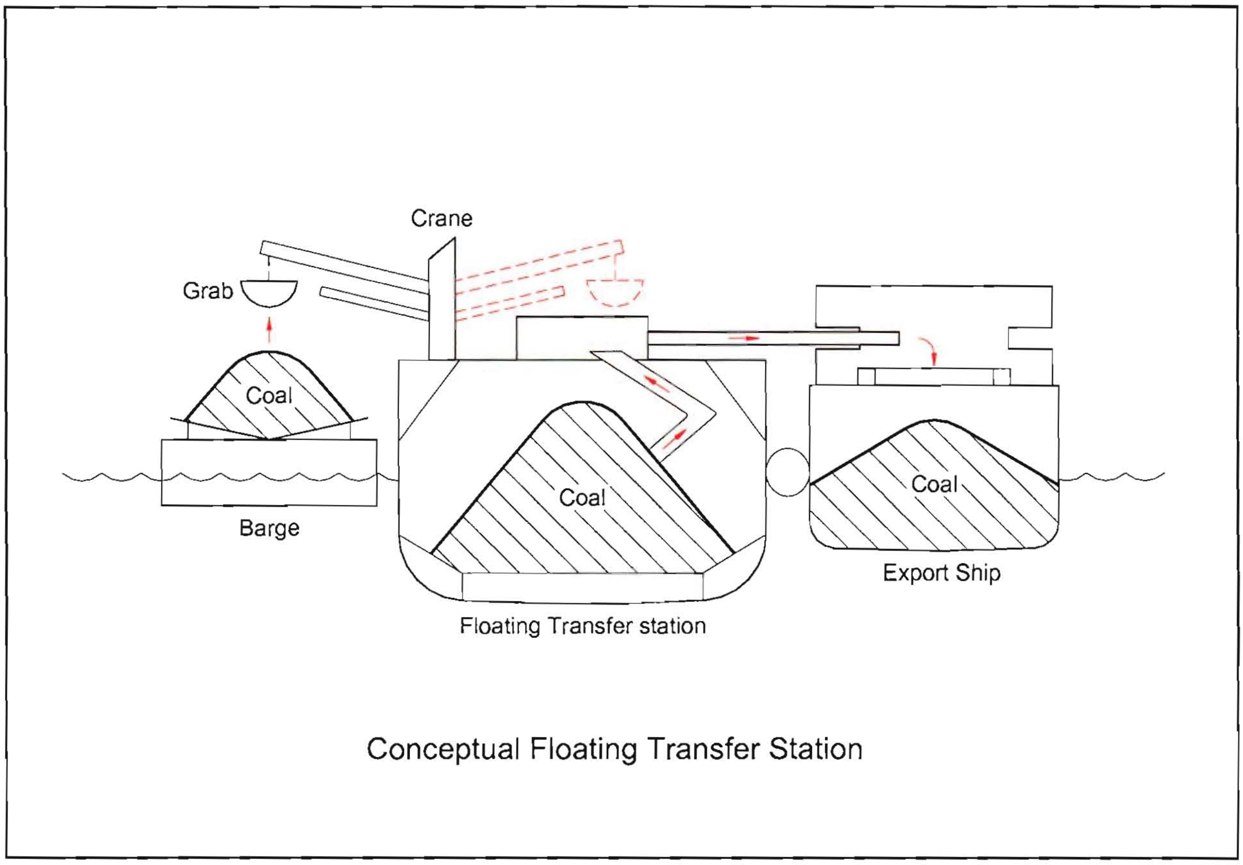
Commodities, such as coal, are barged (or shipped) to the FTS, generally from a port where environmental or geographic constraints restrict loading directly onto larger bulk carriers, then loaded onto the FTS and held until a larger vessel berths alongside the FTS. The cargo is then discharged into the larger vessel for onwards shipment (export).

The process can also work in reverse i.e. a large ship can deliver product to the FTS where it is stored and then transferred to barges (or smaller ships) for distribution to a shore facility.

For an export FTS handling coal, an existing bulk carrier has cranes welded to the deck enabling discharge of the barges using grabs. The coal is loaded into the holds and then transferred to bulk carriers using specialized discharge and conveyor systems. The FTS can hold between 60,000 tonnes and 180,000 tonnes depending on the size of the converted bulk carrier used, e.g., handy size, panamax, post panamax or Capesize.

Figure 1 is a cross section (in concept) of the FTS showing the barge and the export vessel alongside being loaded.

Figure 1: A conceptual floating transfer station (FTS)



An example of a FTS is the "Bukwayuu", (a converted Panamax bulk carrier of 60,000 tonnes deadweight) on Lake Maracaibo in Venezuela.

"This FTS entered service in 1998 and has since handled 40 million tonnes. The handling system is based on four 25 tonne capacity deck cranes to discharge two shuttle barges at 1500 tonnes per hour. The coal can be reclaimed from the holds to feed the ship loading conveyors. Nominal capacity is 25,000 tonnes per day."
Bulk Materials International May/June 2004 page 6

Further information on this operation was reported in Cargo Systems magazine in June 2005.

"Barges then deliver shipments to the Bulkwayuu which can handle throughput of over 700,000 tonnes per month using four Krupp's cranes. They deliver the coal to hoppers set on three portals travelling on rails along the deck of the station feeding three belt ship loaders. Ocean going vessels can be loaded at rates exceeding 30,000 tonnes with storage space of over 64,000 tonnes, offering a buffer should barge operations on the lake be interrupted, thus keeping demurrage costs to a minimum."

Latin America supplement, *Cargo Systems* magazine June 2005

Figure 2: The FTS "Bulkwayuu"

Coeclerici Logistics, working with Carbones Del Guasare, operates the Bulkwayuú floating storage transfer station on Lake Maracaibo

Another example is the 180,000 tonne deadweight *"Boca Grande"* floating terminal moored in deep water just outside the Orinoco Delta facing Trinidad. This loads Capesize ships with iron ore and also tops up Panamax bulkers. This FTS is fed by two 80,000 tonne dwt self discharging bulkers.

The major advantage of a FTS is it allows the deep sea vessel to be loaded independently of the barges which act as a shuttle service backward and forward between the FTS and the point of export (either Westport or Greymouth). The lead in time for setting up a FTS after applicable consents are granted can be less than a year-considerably less time than building a shore based facility. It avoids the requirement to have stockpiles on land and associated environmental problems e.g. dust, noise, aesthetic appearance.

There is no capital dredging requirements or on-going maintenance dredging issues.

In addition, should there be a problem with the coal export (e.g. price, supply problems, mine collapse) the FTS can simply lift up anchor and reposition to another area in the world so the capital cost of set-up is not stranded, as would be the case with shore based facilities.

The other proposal for a transhipment option put forward by Seatow which differs from the use of an FTS is to have a crane on a barge and the export ship loaded directly from barges. The advantage of this system is that coal is not double handled (potentially reducing dust emissions). The major disadvantage is that the time taken to load the export ship is considerably longer (4-5 days compared to 2 for the FTS). It also exposes the export vessel to load constraints if the barging operation is in any way interrupted.

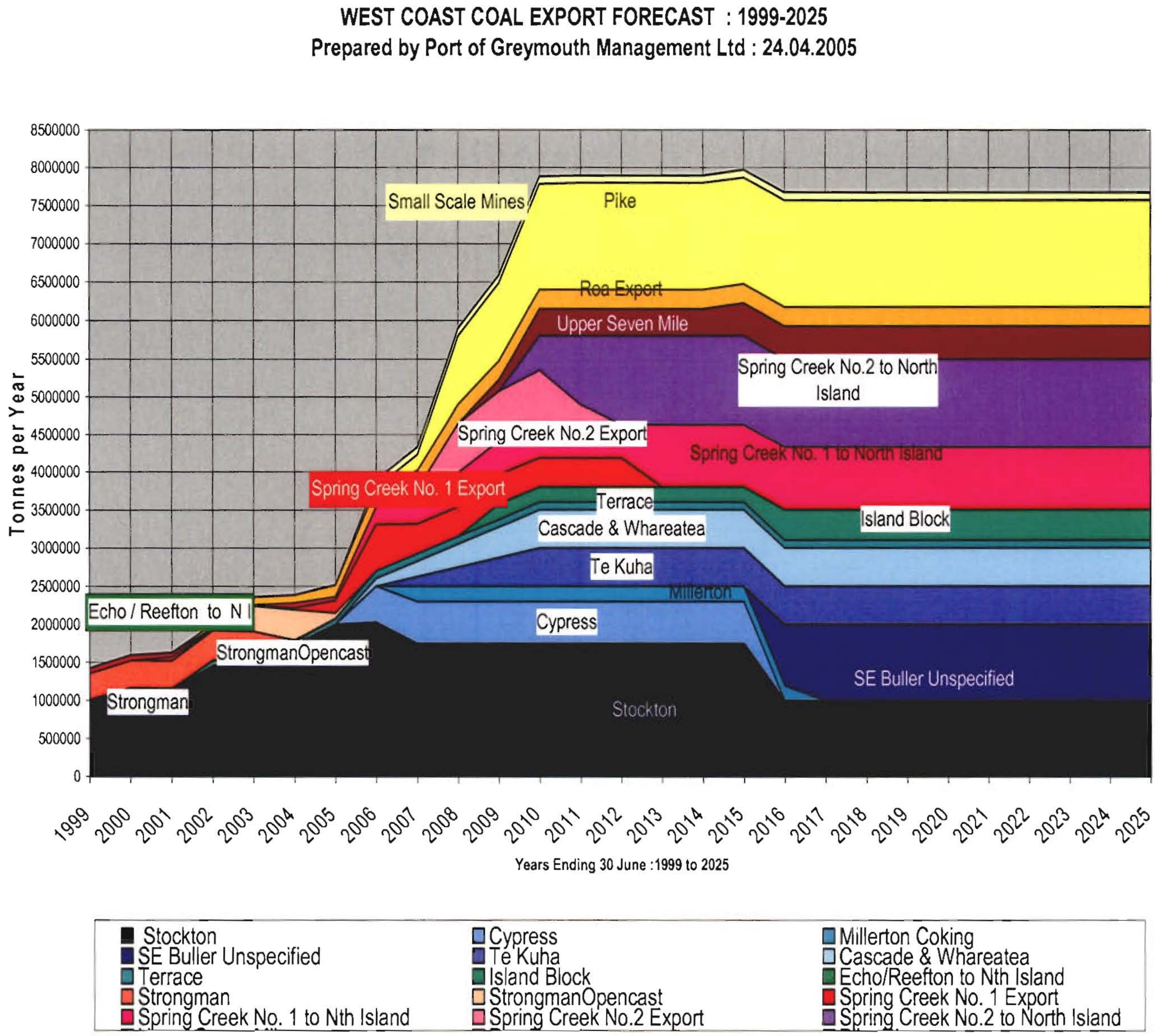
The major advantage is potentially the cost per tonne at the transhipment facility.

However this has to be weighed up against the extra costs of shipping and the costs associated with capacity constraints.

Chapter Six

West Coast Coal Reserves

Figure 3: West Coast Coal export Forecast: 1999-2025.

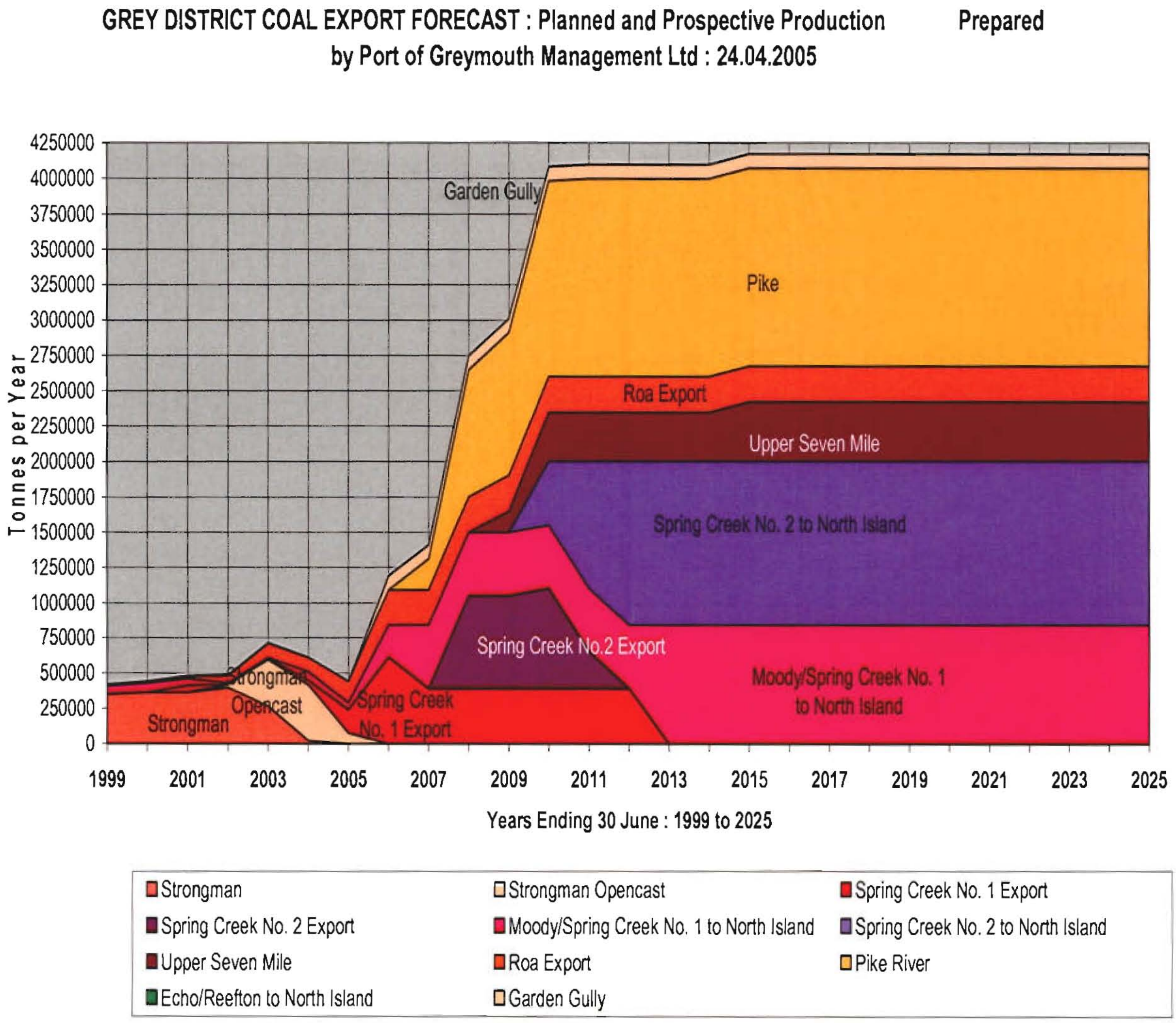


Total coal production on the West Coast has the potential to expand from its current output of 2.4 million tonnes to 7.8 million tonnes over the next 5 years.

Figure 3 shows projected production and sources of West Coast coal.

Looking at Greymouth alone, coal exports are planned to reach 4 million tonnes by 2010. Approximately 50% of this (2 million tonnes) will be available for direct export to offshore destinations. Figure 4 shows the source and volume of the Greymouth coal.

Figure 4: Grey District forecast export coal production.



Given the above, and assuming the information supplied is accurate, it is a reasonable assumption that a continuing supply of coal from the West Coast will be available over the next 20-25 years.

Chapter Seven

Coal: demand side issues

The demand for coal as a factor of production is a derived demand. i.e. the relationship between price and quantity demanded are determined by the demand for the final products where coal is an input.

The three main areas which require coal are

1) Electricity generation (coal fired)
2) Steelmaking
3) Cement manufacture.

As the demand for each product increases, so does the demand for coal. In times of high GDP growth, increasing demand for energy requires greater electricity production. Electricity provided from coal fired stations increases and hence the demand for coal (thermal coal) increases. Demand for coal to fire electricity generation is unlikely to be replaced by other fossil fuel alternatives in the short term.

Figure 5: World Electricity demand by Fuel 1997 to 2028

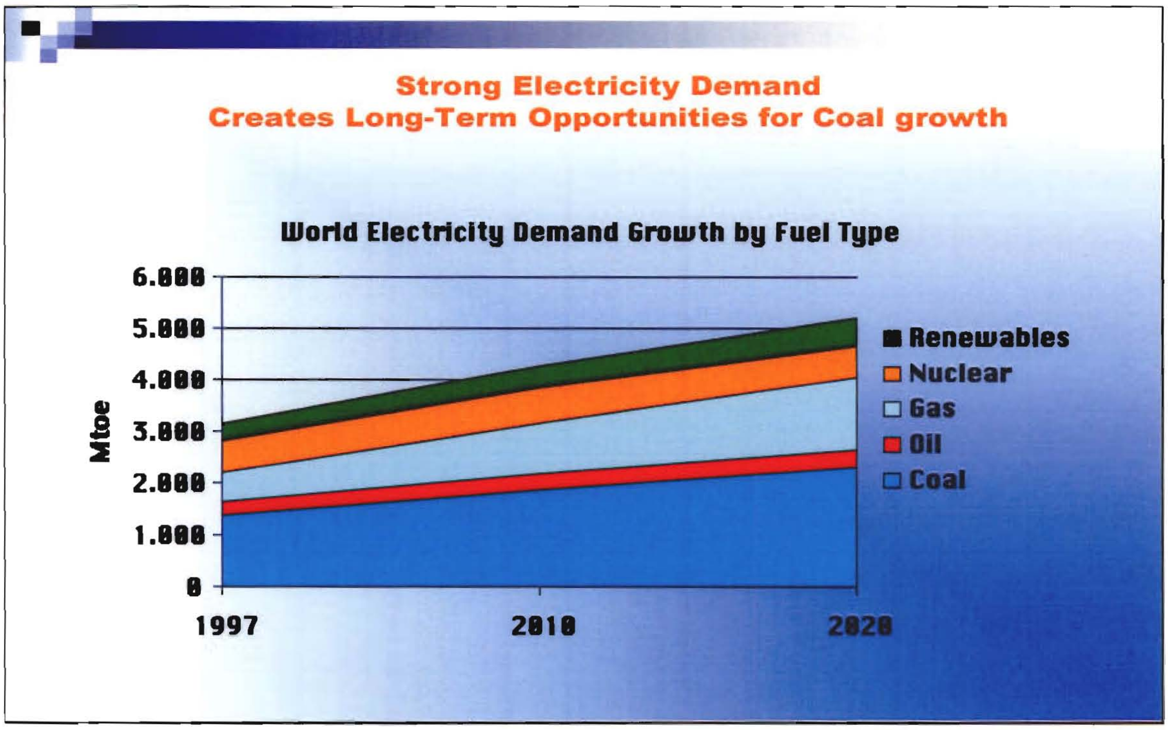


Figure 5 comes from Dr Domenico Maiello's presentation "International Coal Trade and Price developments in 2002' at the United Nations Economic and Social Council –twelfth session-Geneva, 18/19 November 2002.

Other pertinent comments on coal in his presentation were;

a) Coal trade from the present level of approx 550 million tonnes is due to grow to a level of approx 730-750 million tonnes per annum by the year 2020.

b) Coking coal will maintain its role of unfungible component for the production of pig iron in the blast furnace process. Present trade of 200 million tonnes per annum is due to grow to approx 230 million tonnes per annum by the year 2020.

"HARD COKING COAL DEMAND ALREADY NOW EXCEEDS AVAILABILITY WORLD WIDE."

Why is steel production growing so quickly with GDP growth? The answer is that steel consumption in developing economies grows at a faster rate than growth in the economy. Growth in GDP in developing countries like China and India, results in much faster growth of per capita steel consumption than in developed economies. This is because developing economies put more investment into infrastructure (roads, ports, rail, housing, dams, commercial building) than developed economies do. Thus in China steel demand is growing at a faster rate than its economy.

"*International demand for New Zealand coal is high, driven by the need for raw materials and steel in China*"

Elder, Don. CEO Solid Energy; (2004, April 16th) LPC press release.

Chapter Eight

Coal Price

A key assumption is that world coal prices (especially coking coal) will remain at present levels (or better) thus justifying continued export of West Coast coal.
As long as demand outstrips supply then prices are unlikely to reduce.
"Morgan Stanley recently raised its expectations for long term coking coal prices describing the outlook for coking coal producers as very bright, adding that despite a steep change in the hard coking coal pricing with recent settlements quoted at US$ 125 per tonne and higher, the number of new mine developments announced has been relatively low."
Can Infrastructure keep up with coal demand? (2005). *Bulk Materials International:* March/April 2005

Australia, the world's biggest exporter of thermal and coking coal is having major issues with its infrastructure not being able to keep up with current demand. Thus we see supply side issues that help maintain high coal prices.

"The major bottlenecks are seen as the ports in Newcastle and Dalrymple Bay where shippers are facing lengthy delays and demurrage bill. There is work ongoing at Dalrymple Bay Coal Terminal and its operator, Prime Infrastructure, has just announced that it has secured finance necessary for upgrade works. Despite this, the port has a queue of over 50 vessels. Apart from creating mayhem with the rail operators and mine stockpiles, this could put more upward pressure on coking coal prices. Watkins (Watkins is the Deputy Premier and Minister of Transport in the Parliament of New South Wales) *predicts an explosion in demand for hard coking coal that will see Australian exports of coking coal jump by 78 million tonnes by 2014. So where will all this coal go? India is seen as having the greatest impact on the market with a possible 45 million tonnes of additional demand over the next decade as the country's industrialization gains pace. Whilst there has been much talk about China's influence on the market, its coking coal*

imports will increase by a more moderate 18 million tonnes over the period. Western Europe and Brazil account for the rest of the demand, with Japan, Korea and Taiwan accounting for only small increases. Given this scenario of rapidly increasing demand for both thermal and coking coal, there are some very strong arguments for continued high prices. First with oil prices looking like they will remain high for some time, this has a big impact on mining and production costs that will be reflected in profitability. The high oil price also reduces competition from other fuels, particularly natural gas. This could initiate even higher demand while a second reason to expect higher prices in the future is the consolidation of the supplier base. Over 60% of the coking coal market is controlled by five companies and there is a similar situation amongst the thermal production. The third important factor is the restrictions on existing infrastructure that may not be able handle the rapidly growing demand. In Watkins analysis almost all of the new thermal coal demand will be met by Columbia/Venezuela and Indonesia. These countries have a proven track record of responding rapidly to market conditions by expanding infrastructure. In the case of coking coal, almost all of the slack is to be taken up by Australia's Queensland exporters.... They will have to come up with an additional 80 million tonnes of coking coal capacity over the next decade to keep the market in balance."

Can Infrastructure keep up with coal demand? (2005). *Bulk Materials International:* March/April 2005

Confidence in Australia remains extremely high over the future of coal.

"Gladstone will become the world's largest coal exporting port by 2010 following a decision to fast track a $1.8 billion dollar project to develop a third coal handling facility. Premier Peter Beattie yesterday announced that Queensland Co-coordinator General, Ross Rolfe, had declared the proposed Wiggens Island Coal Terminal a "significant project", meaning the planning and environmental processes would be expedited to allow the project to proceed as quickly as possible.

Exports of Queensland coal rose to 140 million tones last year and Mr Beattie said coal producers had signed contracts to further increase production by up to 80 million tonnes in the next five years. He said there was no foreseeable end to the coal boom, with *massive growth in the Chinese and Indian economies tipped to underpin global demand for Queensland coal for decades to come. This is the first time in Queensland's history, I think, that we have been able to be confident of consistent demand well into the future. "We're safely talking about the next 20, 30, 40 years"*

Cole, Malcolm. (2005, October 5th). *The Courier Mail*, page 27.

Discussions with Gordon Ward, General Manager of Pike River Coal Company in November 2004 indicated coking coal had reached US$ 137 per tonne FOB and that Ward's expectation was that long term the price would sit between US $100 to $110 per tonne FOB.

"Major coking coal buyers (JSM, ESM, BSM) for more than a decade elected to keep a squeeze on export prices (in US$) and indeed succeeded thanks to the volatility of certain currencies versus the U.S. and mining factors. In 2004, very unnaturally, coking coal prices have a spread in excess of $100 mt for the same product only depending upon timing of contracting and destination. Therefore in 2005 all prices will jump up to align themselves above the $100 mt level thus filling the unacceptable discrimination of the 2004 negotiations"

Maiello, Dr Domenico. (2004). United Nations Economic Commission for Europe's ad hoc group of experts on Coal in Sustainable Development Seventh Session, Geneva 7- 8 December.

In summary, there is enough evidence to presume, ceteris paribus, that world demand for coal will outstrip supply, maintaining prices at least at present levels.

Chapter Nine

Transport Alternatives

Given that Toll (new owners of the rail operator Tranz Rail) have signed a 13 year transport deal to move 3.8 million tonnes of coal by rail over the Midland line from 2007/2008 and assuming this is done by rail alone and Toll cannot easily expand the rail option further, then this still means that alternatives will need to be found to transport up to 4 million tonnes of coal per annum off the West Coast.

There are a number of different options for the transport of coal off the West Coast.

These include road, expansion of the rail service, construction of a deep water port or offshore jetty, and barging coal to a transhipment point. These different options have been costed relying on published port costs and input from industry sources, and the costs are summarised in the attached spreadsheets (Appendices I – VIII).

These options are now described below.

Northport (transhipment)

The new deepwater port at Marsden Point, a 50/50 joint venture between Northland Port Corporation and Port of Tauranga is a possible transhipment port for barged coal. It offers a number of advantages. The depths alongside its two new berths are 13 metres, deep enough for Panamax and Post Panamax but not deep enough for Capesize vessels. The berths however will be increased in depth to 14.5 metres in 2007. Northport is closer to Asian markets than other transhipment options therefore there are possible ocean freight savings (see spreadsheet model, Appendix IV).

Northport has a lot of available land for expansion that backs on to the new port facility and is relatively isolated from a large population source. Available land is important so as not to constrain expansion and allow good separation of cargo types (e.g. logs and woodchips should not be stored next to open coal stockpiles as coal dust can contaminate pulp logs and/or woodchips, both of which are exported through Northport). Isolation is important as it mitigates port related noise (from ships generators, and ship and shore related cargo operations) which can be 24 hours a day when loading or discharging operations are taking place.

However there are some minor disadvantages. Incoming export vessels must keep clear of a marine reserve area and the anchorage can be exposed in easterly swell conditions. There is no existing infrastructure for coal transhipment and resource consents would be required. The distance for barging is considerable (650 nautical miles) requiring 4 barges to maintain coal supply. The CEO of Northport, Ken Crean, has indicated Northport are not pursuing coal nor making allowance for Capesize vessels. (Ken Crean, personal communication, 20th December 2005).

Port of Tauranga (transhipment)

The advantage of the Port of Tauranga is that it has existing infrastructure for coal receival and storage. Whilst the infrastructure was put in place to handle the importation of approximately 1 million tonnes of thermal coal for Genesis Energy (to be burnt at the Huntly coal fired power station), the facilities could easily be expanded to tranship the same quantity again. Tauranga is recognized within the port industry as a bulk port with strong management expertise in this area.

The disadvantages of Tauranga are the infrastructure may be constrained commercially preventing expansion for a second customer. The port also has a "tidal window" i.e. ships are constrained to sailing/arriving within a certain time of slack tide (High water if there are draft constraints). However, this is more of a perception than a reality as steaming time or stevedoring time can be adjusted to meet pilotage requirements. Presently only Panamax or post-Panamax vessels can utilize the port, not Capesize vessels. In addition Tauranga has an exposed anchorage in heavy easterly swells (which on rare occasions can close the port).

The greatest disadvantage is the long distance the barges must travel from the West Coast (725 nautical miles). This requires a barge fleet of 5. The financial model assumes that the existing facilities would be extended, and a reclaim conveyor and ship loader would be erected to allow coal to be re-exported.

Port of Wellington (transhipment)

The advantages of the Port of Wellington are that it is relatively close to the West Coast and it has a protected deep water harbour providing a suitable anchorage. However it has quite a few disadvantages. The barge trip needs to transit Cook Strait which has a reputation for some severe weather that could cause delays. The barging distance is 122 nautical miles further than the FTS.

Wellington has no infrastructure or consents in place presently to handle the transhipment of coal. Given its proximity to the centre of the capital city (and the presumption of a high amenity value of the harbour), and the declared public intent to undertake some very large property developments ["Harbour Quays is the most significant development in Wellington's commercial property market in the last ten years" (2005, July 14th). Retrieved June 2006 from http://centreport.co.nz/centreport/166.html] it is unlikely that management would pursue coal transhipment. If they did, it would be most probable that a fully enclosed facility would need to be erected. This assumption has been made in the spreadsheet model.

Port of Taranaki (transhipment)

The advantages of the Port of Taranaki are that coal has been transhipped and also imported (though in relatively small quantities) through this port in the past so they have experience with handling coal (100,000 tonnes over the last two years).

A large capital dredging programme is underway to create sufficient depth for Panamax and post-Panamax vessels. This dredging programme will cost $25 million.

Port Taranaki. (2006). *Portal*, page 6. New Plymouth, NZ: Port Taranaki.

The port is the closest one to Greymouth for barging (250 nautical miles).

The transhipment option can be accomplished using an open stockpile which will save considerable capital expenditure. Port Taranaki is creating space within its present port operational area which will allow for stockpiling of sufficient coal to load 65,000 tonne parcels into Panamax size bulk carriers.

The disadvantages of the Port of Taranaki are that it has an exposed anchorage and the harbour can be subject to surge, interfering with cargo operations. However, delays to the export ship at Taranaki, due to these constraints, have not been costed in the spreadsheet model.

At the time of concluding this dissertation it was publicly announced;

"Port Taranaki has won an $80 million contract to export coal from a new mine on the South Island's West Coast. The contract, initially for 18 years will transform the port to second only to Lyttelton in terms of coal tonnages handled. At its height, the operation will see the port handling 1.3 million tonnes of coal a year, a figure that will represent more than 30% of Port Taranaki's entire cargo tonnages.

The contract was signed yesterday between Pike River Coal Company Ltd and the Transport consortium...represents a $80 million supply chain."

Humphreys, Lyn., Maetzig, Rob. (2005, December 24th). Port Taranaki wins $80 million coal contract. *Daily News* page 1

It was further reported a total of $90 million is to be invested in developing the supply chain for this trade, including new facilities at Port Taranaki. This includes a new crane capable of handling 800 tonnes of coal an hour (to discharge the barges), construction of load out equipment to load the bulk carriers at rates of up to 2000 tonnes an hour, and some modifications to Moturoa Wharf.

<u>Shakespeare Bay (transhipment)</u>

The advantages of Shakespeare Bay (Port Marlborough) are many. It has New Zealand's deepest berth at 15.7 metres (with the ability to be dredged to 18 metres). It is protected from wind and swells with a small tidal range.

It has existing consents for the stockpiling of coal on its 8 hectare reclamation.

The Marlborough Sounds provide excellent deepwater anchorages protected from all weather. Currently the 200 metre single berth has less than 10% berth utilisation.

The disadvantages are that there is strong environmental lobby in the Marlborough Sounds which would require the port to expend large amounts in capital to ensure fully enclosed and dustless storage, handling and loading facilities. In addition all barges would have to have hatches (to ensure no dust escape into the Sounds) as opposed to being open, increasing the barging costs. Fully enclosed receival, handling, storage, reclaim and loading facilities require greater capital expenditure. The increased cost to cover the requirement for enclosed barges is not included in the spreadsheet model.

The extra distance increases the barging cost per tonne over barging to the FTS (though this is only fractionally more expensive than the Port of Taranaki barging option).

The port is 100% Council owned and therefore more open to political influence (due to strong and well organized pressure groups) that may constrain coal transhipment facilities being constructed.

At the time of writing both management and directors of Port Marlborough had abandoned the idea of coal being transhipped through Shakespeare Bay. Solid Energy in their 2005 Annual Report is quoted as saying they are no longer investigating the potential for a coal export port at Shakespeare Bay.

"Coal Transport", (2005), Solid Energy Annual Report page 26.

Port Kembla, Australia (transhipment).

The advantages of Port Kembla as a transhipment port for West Coast coal are that wharfage rates are typically a lot lower than New Zealand. (A$0.70 per tonne compared to NZ $3.00). This price differential is entirely due to economies of scale. Tens of millions of tonnes of coal gets exported through the big Australian coal ports (Newcastle, Port Kembla, Gladstone and Dalrymple Bay) so the ports' infrastructure can rely on large volumes by which to recoup investment. Port Kembla also has experience at transhipment operations as coal from the Roa mine has been barged from Greymouth to Port Kembla, (albeit in small quantities), for onward export.

The disadvantage of Port Kembla is that it exposes the NZ exporter to the Australian waterfront, with its heavily unionised work force and possible disruption due to strike.

Additionally it is the longest distance requiring a larger barge fleet of six utilising the biggest barges capable of crossing the West Coast bars, increasing unit barging costs considerably. Increasing volumes of Australian export coal may cause capacity constraints at Kembla.

<u>Port of Lyttelton</u> (LPC)

The advantage of using Lyttelton as the export port, either by barging, by rail or by road is that this port is well set up and experienced at coal handling. Recently they have invested $30 million dollars in upgrading their coal storage and handling facilities.

Coal upgrade facility complete (2004, April 16th),

Retrieved July 2005 from www.lpc.co.nz/Tempfiles/temp Documents/Media%20releases/2004-04-16%/20Coal%Upgrade.pdf].

LPC have experience at transhipment as coal has been barged to Lyttelton from the West Coast when the rail has been unable to cope with contractual volumes.

The disadvantage of barging to Lyttelton is the distance. Lyttelton has not been modelled as a barging option on the basis of extra distance (both for barges and export vessels) and on the basis that if Lyttelton was to be chosen as the export port then coal would most probably be railed.

The disadvantages of using Lyttelton via rail are that coal handling and loading facilities have to be shared with Solid Energy. Solid Energy has an equity stake in the coal handling facilities and may not make them available to third parties.

"State owned Solid Energy currently has a monopoly on the Midland Line's carrying capacity. It has also paid for most of Port Lyttleton's coal handling facilities and, consequently, has the sole rights for the use of those facilities by way of contractual arrangement with the Lyttelton Port Company".

Sea Terminals Ltd, Coal Trans-shipment Facility Golden Bay, New Zealand,

Assessment of Environmental Effects April 2006 page 20

It further exacerbates the strategic risk of having only one export option. The berth is draft constrained to 12.2 metres and can take Panamax ships only. The stockpile area can also be constrained in that Solid Energy can have up to 15 "varieties" of coal stockpiled in the stockpile area.

Port of Nelson

Port of Nelson has not been explored as a viable transhipment option because it is currently too shallow to accommodate large coal export ships.

Rail

The advantage of using the rail network to get coal to Lyttelton is that the infrastructure is in place and the network is connected to an existing port facility. Don Elder CEO of Solid Energy has indicated they wish the rail capacity to increase to handle four million tonnes of coal per annum over the next five years. *"We still have a number of challenges going forward to grow our annual exports to more than 4 million tonnes. In particular we are working with David Jackson and his team at Tranz Rail to improve reliability and upgrade capacity on the Midland Line between the West Coast and Lyttelton".*

Coal upgrade facility complete (2004, April 16th)

Retrieved July 2005 from www.lpc.co.nz/Tempfiles/temp documents/Media%20releases/2004-04-16%/20Coal%Upgrade.pdf.

The disadvantages of using the rail network are that it is in a poor state of repair (refer previous comments) and the Otira tunnel is a major constraint. The tunnel was built in 1918. Its steep (gradient 1:33) and the design of the tunnel allows only one train to transit (extra locomotive power is required to assist laden coal trains through the tunnel). There is then a time constraint until the next train can enter the tunnel and have enough clean air to maintain combustion on the extra locomotives required to pull the laden trains through. "after the train has exited the tunnel the second fan kicks in and helps purge the tunnel of the diesel fumes. This process takes 23 minutes in the uphill case".

Pettigrew, Bobby, (2005). Event report, Otira Tunnel Site visit. IPENZ West Coast Branch. Available http/www.ipenz.org.nz/westcost/docs/Eent_Report_050618.pdf.

There are capacity constraints on the existing rail link that will require more passing bays to be built. The extra passing bays would enable more trains to be on the track at any one time. In addition, existing passing bays will need to be lengthened if longer trains are to be used. Toll Rail have been using new technology which allows for better wheel traction enabling locomotives to increase their towing power, which means more wagons can be added, increasing the length of the trains. "...progressive deployment of 30 wagon trains, which can carry 1500 tonnes of coal compared to the 1200 tonne capacity of the previous 24 wagon models. Incorporating these heavier trains has also seen the progressive upgrade of Toll Rail's DX locomotives with GE Brightstar traction control and increased horsepower".

Record Solid Energy Volumes.(2006, April 29th). *Shipping Gazette*, Page 19.

On the basis of Pike River volumes and assuming that trains can take 1500 tonnes at a time (50 coal wagons, each carrying 30 tonnes), an extra 800 train trips per year will be required (approx 15 trips per week). This would require new rolling stock, new passing sidings and an innovative solution to the Otira tunnel problem. The extra capital cost will probably increase the per tonne transport cost, setting aside the extra maintenance issues created by an approximately 60% increase in track utilisation.

Additionally, the same stockpile and berth constraints apply at Port Lyttelton as outlined previously, even if the rail network could handle the extra volume, unless the coal was railed to another port e.g. Timaru or Shakespeare Bay. The latter has not been explored on the basis that the rail distance is essentially doubled, and Timaru has not been explored on the basis that the only berth deep enough (North Mole) is used for container traffic. A conversation with the operations manager (K Michel) at Timaru indicated they had chased the coal business about 15 years ago but they had not seriously re-looked at it since then. (K. Michel, personal communication August 2005).

Road

One argument is that road transport could possibly be used to move coal to Lyttelton (or perhaps Shakespeare Bay). The advantage with using trucking is that it is highly flexible and can be introduced relatively quickly. An industry source indicates long term contracts for bulk cargo could be as low as $0.15 cents per tonne per kilometre (Harris, Ken, Director NZL trucking, personal communication 9th September 2006.) based on contract tonnage exceeding one million tonnes. The road transport costing model in Appendix VII also indicates a price per tonne kilometre in line with industry advice. This would give a road cost, based on a trucking distance of 265 kilometres, of approximately $39.75 per tonne. Total cost including Lyttelton port charges brings the roading option up to $47.28 per tonne.

The disadvantages of using trucking are the number of trucks required to maintain delivery rates. A fleet size of a minimum number of 71 trucks would be required to maintain delivery rates. This assumes each truck is capable of doing 2 round trips per day, 365 days of the year. It is a relatively long distance over mountain passes subject to closure in winter months. The road link has high "tourist amenity" value which would be severely impacted by 52,000 truck movements per annum. It is possible that there may be constraints imposed on the operating hours of the trucks or on the numbers of trucks allowed on the road at any one time which would constrain delivery volume rates. This would increase the costs of the roading option.

In conclusion, road transport to Lyttelton (or another export port) is not practicable, either operationally or financially.

Offshore Jetty

An offshore jetty is simply a long jetty, extending from the shore line out into deep water (25 metres depth). The jetty is built strongly enough to withstand the berthing forces of large ships as well as the swell and sea conditions likely to be experienced. Coal is moved via a conveyor belt to a ship loader and then loaded directly on to export ships (30,000 to 65,000 tonne DWT ships).

Advantages

There are some advantages to an offshore jetty. Briefly they are;

1) Coal can be loaded directly to export ships. There is no double handling.
2) The depth of water (jetty in 25 metres of water) allows for deep draft vessels i.e. Capesize loading to maximum draft.
3) The jetty is not prone to bar harbour restrictions.
4) The jetty can be close to the major coal source giving internal land transport savings.

Disadvantages.

However there are a number of disadvantages in building an offshore jetty. Briefly they are;

1) High Capital cost. Initial public information put the cost at approximately \$170 million (Coal Jetty Consents Granted. (1998). *New Zealand Mining Volume 23, 7-8*) for the offshore jetty proposed by Solid Energy for construction at Ngakawau (north of Westport). A subsequent report by KPMG, "Buller Coal Jetty Review" done in October 2003 put the capital cost of a jetty at approximately \$219 million
2) Long lead in time for construction, possibly 4 years from consent application to completion of construction.
3) The jetty would be exposed to West Coast swells and this has a twofold effect;
    a) Swell can build quickly and time to stop loading, start engines and get tugs mobilized could jeopardise the safety of the ship and the jetty. (refer previous comments by Captain D Barnes).
    b) Restrict days a ship can actually get alongside.
4) The area has no suitable anchorage and ships would have to anchor in Golden Bay to wait getting alongside.
5) High sunk costs in the event of coal production falling. It would be difficult to re-route coal from other fields to the jetty.
6) The jetty is specific to one product type and therefore a lack of flexibility increases the risk margin on the investment.

Based on an operating life of 50 years and a cost of say \$220 million and a capital return of 12%, the capital charge would be close to \$26 million per annum. Operating costs would be approx \$8 million to \$10 million giving a cost per tonne of close to \$26.43 (based on 1.3 million tonnes per annum). Appendix VIII gives a breakdown of how this figure is arrived at. However, given the coal reserves reported by Solid Energy for the Buller/Stockton area it would be prudent to cost the jetty option on a 20 year life (depreciation 5% per annum instead of 2%). This increases the cost per tonne to \$29.70.

Deep Water Port

Advantages

There are a number of advantages to having a deep water port on the West Coast and previous engineers of both the old Greymouth and Westport Harbour Boards had done considerable work (in the 19th century) investigating possible sites. Two were identified; one at Raumunga, just north of Greymouth, known as Port Elizabeth, and one at Cape Foulwind. The Cape Foulwind site was re-visited in a study done for Milburn Cement in the early 1990's. The author has not attempted to obtain a copy of this report on the basis that no attempt has been made by Milburn (now called Holcim) or another party to apply for consents to build a port.

Renee Bakx (ex CEO Port Otago), stated that the project would have been "a goer if Coal Corp (Solid Energy) would have joined the project and dedicated tonnage along with Milburn's cement volumes". (R Bakx, personal communication, July 2005).

It is presumed that this proposal has never gone ahead as costs associated with protective groynes and dredging (a rock reef extends into the area required for the port) made it marginal. The costs associated with building a deep water port have not been explored.

Specific advantages of a deep water port are:

1) It is not prone to bar harbour restrictions
2) An export ship can load directly.
3) It is possible to have a multi user berth and other products can also use the port e.g. cement, gravels and timber products.
4) The port can offer protection to the ship whilst it is alongside.

Disadvantages

1) Resource consents would be required. Consent issues would be considerable based on the fact that substantial dredging would be required as well as the building of seawalls of considerable scale creating seabed occupation issues.
2) Long lead in time to construct the port.
3) High capital costs.

The later two alone would considerably affect the return on investment (R.O.I.).

Floating Transfer Station

Strengths

The strengths of an FTS anchored in Golden Bay are that it is the shortest barging distance to Greymouth compared with the other port options, Golden Bay offers protected anchorage from both sea and swell and there are no issues with draft of export vessels as the FTS would be anchored in 25 metres (at Chart Datum) of water. The operation is distant from people, mitigating noise and visual issues. The FTS is flexible in that storage capacity is scaleable. It does not involve large investment in land based infrastructure.

Another major advantage of an FTS is that if for some reason the coal supply ceases (international price collapses, physical issues at the mine site make it uneconomic to mine, collapse of the transport chain) the FTS can simply pick up its anchor and steam off to another location in the world (i.e. there is no stranded capital), therefore the risk factor attached to the capital employed will not be as high as capital employed in a fixed location at a port.

With respect to the use of an FTS to tranship coal off the West Coast (either coal from Westport or Greymouth) it also means lowered costs in the barge fleet as the configuration (size of barge and or number of barges) will be less than for the other transhipment options.

One of the strongest endorsements for the use of the FTS is the ability to load Capesize vessels with no extra costs associated with dredging, or the scale of ship loading equipment. However, despite the fact that the model (see Appendix I) shows the cost advantage of the FTS over the other two options (Shakespeare Bay and Port Kembla), Capesize shipments have not been explored for two reasons. These are:-

1) NZ coking coal is used in small quantities in a total blend and it would be highly unlikely that a steel producer would want such a large shipment of NZ coking coal in one shipment.

2) Most of the Japanese ports that import NZ coking coal have draft restrictions that would prevent Capesize vessels berthing.

There may be a market for Capesize vessels ex Australia to top off with NZ coking coal to other markets (eg Brazil) but these options have not been explored here.

Weaknesses

The weakness of the FTS being in Golden Bay is that it is anchored in an area of high environmental value. If, however, the presence of the operational FTS creates environmental issues that are in fact an insurmountable, the highly mobile option is a strong endorsement for allowing it to happen as it will not be a case of "once it's in its too late" as the FTS will simply be able to pick up anchor and steam off, i.e. it is possible to trial the concept with a "no regrets" policy. The proposed anchoring position is outside the Separation Point exclusion zone which protect Bryozoan Beds and outside the Aquaculture Management Areas.

However, one major operational constraint, identified by the Shipping Manager (Chris Russell) at Solid Energy, is that the FTS is not ideal for handling many different types of coal that may need blending at loading to suit the requirements of a particular buyer. (C Russell, personal communication April 2005).

Whilst the FTS can handle two different types of coal it is not ideally suited to handle more. Coal from Stockton, for example, can be held in up to six different stockpiles at Lyttelton. This restriction could be overcome by blending at either the mine site or at Port of Greymouth prior to loading on the barge.

The Consent issues are not substantially different than for a land based facility except for issues around ballast water discharge and occupation of the sea bed.

The Consents required are:

Occupation of Space within a Coastal Marine Area.

Discharge of Coal Dust to Air and Coastal Waters.

Deposition of Fugitive Dust and Coal fines.

Deposition of Coal Fines on Sea Floor.

Ballast water discharge consent is not required as it falls under the Bio-security Act.

No consent is required for Transhipment at sea as it is recognised internationally and domestically as a fundamental maritime right.

Consents for discharge of sewage effluent will not be required as the operation will comply with Regulation 11(2) of the Resource Management (Marine Pollution) regulations 1998.

No navigation consents are required although permission is required from Maritime New Zealand.

The costs of obtaining Resource Consent, and assuming the process goes to the Environment Court, would be in the order of $200,000 to $300,000. Assuming the latter, this cost amortised over 20 years would only add $0.02 cents per tonne to the cost of the FTS option. Even if costs were on a scale of ten times that amount it would still not be material to the FTS option. In fact resource consent costs would have to be in the tens of millions of dollars before the impact was significant enough to prevent it going ahead.

There may be increased labour costs with the relevant maritime unions (which include the Maritime Union of NZ (formerly New Zealand Seafarers Union), the Merchant Service Guild and the NZ Engineers Union) demanding increased manning requirements and/or the use of New Zealand seafarers. Depending on the number of NZ seafarers and the negotiated conditions on board, operational costs may be higher than the model assumes.

Chapter Ten

FTS operational requirements

The storage capacity required at the FTS will be a function of the size of export shipment and the delivery rate of the coal which in turn is determined by the number of barges and the output of the coal from the mine source. Additionally, enough coal will need to be held in stockpile to allow for late arrival of an inbound export ship or delay in supply due to barges not being able to negotiate the bar harbour or being delayed due to bad weather.

Typically when a charter is set there is a window of 10 days for the ship to arrive at the FTS. Therefore the FTS has to be able to hold at least one shipment plus a minimum of ten days delivery from the barges. (Otherwise the barges will have to stop delivering and there is a constraint on the continuous operation of the supply chain). For example, assuming (say) Panamax size parcels (50,000 tonnes) and a mine production of 1.3 million tonnes per annum then there will be 26 shipments per annum or one every fortnight (on average) . The delivery rate per day (on average) will be 3561.64 tonnes (1.3 million divided by 365 days) therefore the FTS will have to be able to hold a minimum of 86,000 tonnes. Note: it is assumed that the operation will not be constrained by statutory holidays. Assuming handy size parcels (30,000 tonnes) and a mine production of 1.3 million tonnes per annum then there will be approx 43 shipments per annum, or one every 8.4 days. Assuming the requirement to hold two shiploads then the stockpile will have to be 60,000 tonnes.

The economics of having a smaller stockpile (therefore the FTS can be smaller and perhaps cheaper) and increasing the barge fleet size and relying on both the stockpile and coal on the barges to fully load the export vessel has not been explored. Such an operation imposes constraints on both the barging operation and potentially, should barges be delayed, on the export vessel being able to sail. The costs of such constraints may offset any gains in having a smaller FTS (though this would be a potential case for further study).

Position of FTS

The position 40 degrees 38.5 minutes South; 172 degrees 50.6 minutes East in Golden Bay is an ideal place to position a FTS. This position is marked by the diamond in Figure 6. Water depth is 25 metres which is sufficient for a Cape Size vessel at deepest draft. The bottom (seabed) is identified as Mud and broken Shell which is perfect holding for a vessel of this size at anchor. This position is 7.5 nautical miles from the closest land.

Figure 6: Anchor Position for FTS.

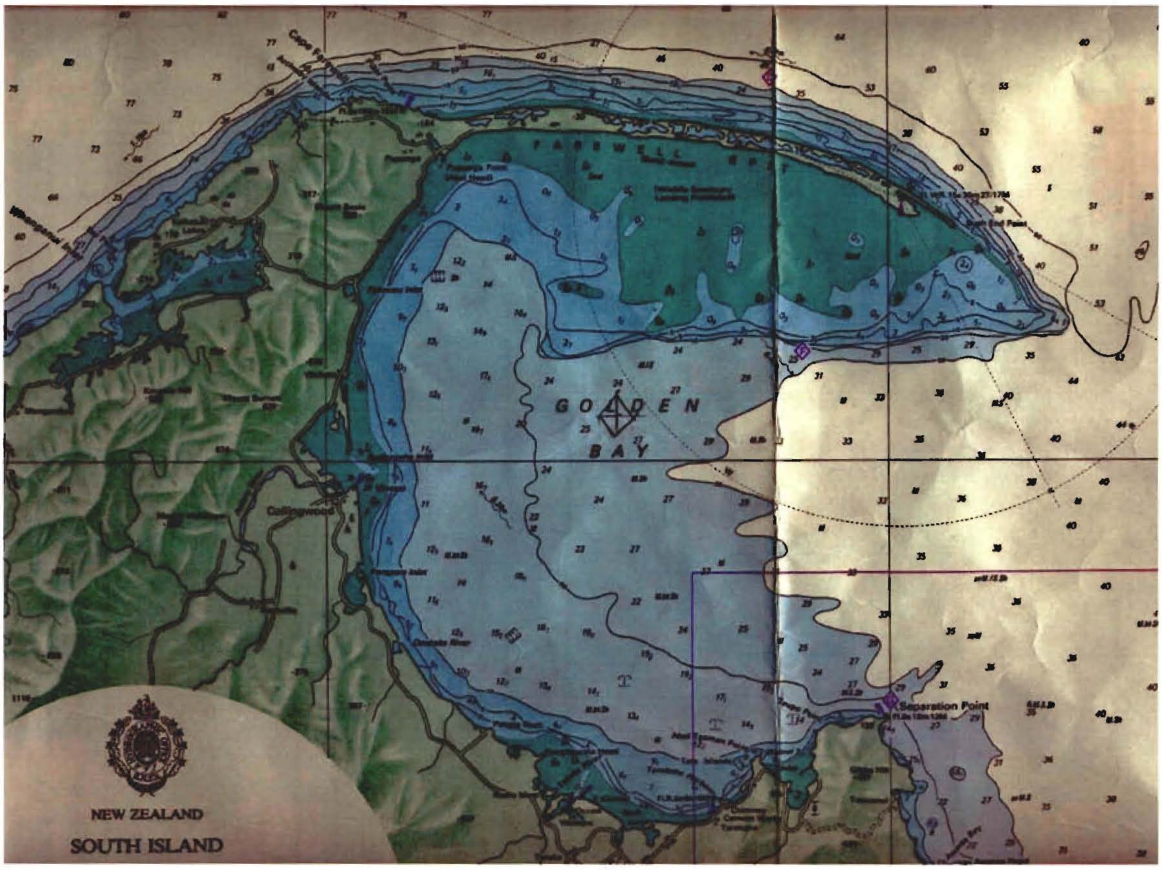


Chart Reference NZ 61 Karamea River to Stephens Island Scale 1:200,000.

In the opinion of Captain Jim McMaster, (current pilot (and ex Harbourmaster) for Port Taharoa iron sand facility) the extreme weather conditions, wind and more significantly swell, precludes a FTS from anchoring off either Westport or Greymouth, or on any other exposed part of the West Coast. (J. McMaster, personal communication, 20 July 2006).

The identified position marked in Figure 6 is well sheltered and exposed only to an easterly wind. With an open fetch of only 45 miles to the east, sea height would only reach 1.5 meters maximum. Farewell Spit to the north protects the FTS from both wind and swell. Coeclerici, an Italian firm that specialises in building FTS's, has indicated that the smallest FTS (a converted panamax of 50,000 tonne DWT) can continue to operate in sea and swell conditions up to 2 metres high and remain operational in winds up to 25 knots.

Port Tarakohe is 11 miles to the south and could be the base for a harbour tug if one was required (approx 1 hour steaming away).

There are a number of potential issues with having a FTS anchored in Golden Bay. Firstly, being within 12 nautical miles of the coast it will come under the Resource Management Act and the District Plan of the Tasman District Council. The Maritime Safety Authority (now renamed Maritime New Zealand) also has jurisdiction over the activities of the FTS.

There are safety issues in terms of lighting and navigation aids as well as an expectation the applicant will address any potential conflicts with existing users, such as recreational, commercial fisherman, recreational fisherman and conservation groups. Visual and cultural issues may need to be addressed. Visual issues are to an extent mitigated by distance from the shore that the vessel is anchored. Cultural issues will require consultation with local Iwi.

The NZ Customs Service would need to attend when incoming ships arrive to clear the crew, sight passports and issue a vessel clearance before cargo operations can start. This can be done by attending the FTS using a helicopter, a similar exercise to that which is done now at the Taharoa offshore iron sand terminal.

Ministry of Agriculture (MAF) officials would need to attend to give the incoming vessel a bio-security clearance. All ships garbage will need to remain on board so there will be no issues of quarantine garbage disposal. In the event that crew need to be landed or there are bio-security issues, the Port of Nelson has the necessary first port of call clearance facilities for both Customs and MAF.

Maritime New Zealand (formerly MSA) have indicated they would take an interest to satisfy themselves as to anchoring arrangements, navigation safety with having a permanently moored vessel, issues of ballast water discharge and coal discharge to the sea. In addition, a full risk assessment would be required as to piloting, ship handling and tug requirements (depending on type and size of export vessel) before they would approve of a FTS anchored in Golden Bay. Ministerial consent would be required for occupancy of the seabed.

Sea-Tow Ltd, the New Zealand tug and barge operator is in the process of applying for a consent for a barge (105 metres long by 30 metres wide) to be anchored in Golden Bay to tranship coal.

Sea Terminals Ltd, Coal Trans-shipment Facility Golden Bay, Assessment of Environmental Effects (AEE), April 2006.

Their AEE identifies these issues and methods of mitigation. Detailed reproduction of the issues raised in the 103 page document is beyond the scope of this dissertation.

Chapter Eleven

The Spreadsheets

The spreadsheets attempt to capture all costs for the various transport options described above. What follows is a brief description of the logic behind the methodology of calculating costs and assumptions made in the spreadsheets.

Barging

The number and size of barges are a function of the following four factors.

1) The maximum size barge that can transit the bars of Westport and Greymouth. Currently this is approximately 120 metres long for Westport and 109 metres for Greymouth. This maximum length is presently determined by the width of the river and the ability of the barges to "swing" in the river. The barges need to be turned in the river prior to sailing so the bow of the barge faces into the incoming sea and swell when departing and crossing the bar. However, with alterations to training walls and with the construction of "turning knuckles" the maximum length can be extended to 130 metres at each port. The hold capacity of the largest ideal barge would be 10,000 tonnes.

   The ideal maximum draft would be 5 metres. (Any increase in draft will impose too great a restriction on when the barge can transit the bar due to varying bar depths and having to wait for high water).

2) The volume of coal to be transported and the number of voyages the barge is required to do to shift the coal. For example if 500,000 tonnes of coal per annum need to be shifted and a barge can do 70 trips a year, then it needs to be 500,000 divided by 70 equals 7143 tonnes capacity. The number of trips a barge can do in a year is a simple function of the distance to the transhipment port (and return) divided by the speed of the barge divided into 365 (the number of days in a year) multiplied by 24 (hours in a day) minus an allowance for possible delays.

3) Any constraints at the loading port of either the size of the stockpile or the number of berths available will affect the efficiency of delivery rates. Valuable work of the effect on barge capacity required when stockpiles are constrained has been published by Steve Moynihan of Opus Consultants in his paper "Optimising Infrastructure and Ship Size for a river Port" delivered to the Coasts and Ports Australasian Conference 2003. The conclusion of his paper is that constraints on stockpile size introduce waiting time for barges which constrain total volume through the transport chain. The result for the transhipment option is a higher per tonne cost for barging and potential delays to the export vessel (and hence extra shipping costs).

The assumption with the transhipment model is that there are no constraining issues at the load ports with either stockpile size or berth availability i.e. it is assumed that whatever transport option is chosen the supply chain land side can, and will be optimised.

4) Constraints due to environmental factors on the bar entrance (depth, swell height, river flow, set [current across the entrance], and wind and sea conditions) as well as en-route weather conditions (swell, sea and wind) can increase the time taken to do a round trip and thus reduce the number of trips a barge can do per annum. This means that to maintain capacity of product movement barge size needs to increase. If the capacity required exceeds the maximum barge size then more barges are required.

The spreadsheet takes double the distance (to reflect a return voyage) from Greymouth to the transhipment port. Coastal distances were obtained from the NZ Nautical Almanac. *New Zealand Nautical Almanac 1999*, page 195, published by

Land Information New Zealand, Crown copyright 1998.

In the case of the FTS, courses were laid off on the appropriate chart and in the case of Port Kembla calculation by Traverse table was done using "Norries Tables".

The steaming distance is divided by 7 knots (the average speed of the barge which is approximately 6 knots loaded and approximately 8 knots empty) to get a round trip steaming time in hours. Technically, assuming 6 knots loaded and 8 knots empty, this is not quite exact as it underestimates time taken by 2.1% ($x/6 + x/8 > 2x/7$) and it introduces a bias slightly against the FTS but speeds are approximate.

Port time, depending on the barge size (see Appendix III), to allow for loading the coal at Greymouth and discharging it at the transhipment point is added to the steaming time. Environmental delays calculated for the transhipment port option (see Appendix III) are also added. This total time is then used to calculate the number of potential barge trips per week (or per year) and then by dividing the delivery rate required per week by the number of potential barge trips to give a barge capacity required per week.(see Appendix I). This can then be met by a combination of barge size and or barge numbers. For example, if 18,000 tonnes capacity is required per week, this can be met by three 6000 tonne barges or a 10,000 tonne barge and an 8,000 tonne barge. Analysis of the costs of either option will give a least cost alternative for a set volume of coal to be transported.

Costs associated with the barge fleet configuration required (size and number) to convey the coal to the transhipment port (see Appendix II) have been calculated.

Capital and operational costs of barging are based on information supplied by an international barge operator, who wishes to remain anonymous for commercial reasons.

Assumptions (based on information provided by an international barge operator) are that the write off period for the barge and tug are 20 years (5% depreciation per annum), finance costs of 7% and equity return on the investment of 12% are used to generate a capital expense per annum for each of the tug and barge size options (10,000 tonne capacity, 8000 tonne capacity or 6000 tonne capacity).

Variable charges are maintenance (4% of capital cost p.a. which includes a provision for docking), insurance costs (2% of capital cost p.a.) and labour costs based on a manning level of 5 people per tug (on equal time on/time off) with average wage of $65,000 per annum.

Fuel costs are based on the consumption rate for each tug and barge size.

There is a further sundry charge to cover all other expenses (providoring, ACC, leave entitlements, crew expenses and an administrative charge). All of the costs for each transhipment option then produce a cost per tonne.

Ocean Freight Rate Savings

The datum point is assumed to be the FTS anchored in Golden Bay. Any greater distances (higher costs) or lesser distance (savings) by the export vessel (assumed to be Panamax or Capesize vessel) calling into another transhipment option are converted into a price per tonne saving (see Appendix IV). For example, a Panamax ship calling into Marsden Point would save 285 nautical miles of steaming (over the FTS position). This equates to 19 hours steaming at 15 knots (assumed average speed). As the ship would have to steam this distance twice if it was coming from Asia (though not necessarily if it was delivering coal to South America or Europe via either Panama Canal of Cape Horn) the total saving is two times 19 hours, or 38 hours, which is equivalent to approximately 1.58 days. The daily charter rate for a Panamax was approx NZ $31,060 (June 2005) per day (Clarkson Research Studies. (2005) Shipping Intelligence Weekly, ISSN: 1358-8028, 8 July, 2005) therefore the ocean freight savings would have been approximately NZ $49,178. Assuming a load of 50,000 tonnes then the saving is NZ $0.98 per tonne.

There are some sensitivity issues as the charter rates for bulk carriers can be volatile and change quickly. *"Shipping owners could be in for choppy time this year with shipping rates predicted to fall for the second straight year. Revenue for the largest dry bulk vessels is likely to average US$32,000 a day this year compared to US$37,552 a day last year."*

Carrier glut hits shipping revenue. (2006, January 17).-*NZ Herald,* Page 1 Business News

Port Costs

The Port costs for each shore based transhipment option are calculated and converted to a cost per tonne (see Appendix V). Typically the export cargo will attract a number of charges. If the cargo is sold FOB (free on board), the exporter is responsible for all costs until the cargo is on the ship. The buyer is responsible for ocean freight and all charges that attach to the ship at the loading port. The assumption is that port costs are based on the coal being sold FOB as this ensures cost neutrality when comparing all of the transport options.

Wharfage

This is a charge to recover the costs of port infrastructure, i.e. wharves, roading and other overheads of running a port, as well as to generate profits. The model uses the advertised wharfage rate at each port.

Storage

This is a charge to recover the value of the land plus any improvements to the storage area e.g. pavement surfaces, drainage, dust control systems and resource consent monitoring costs. It also acts as a disincentive to the exporter to use the port area as a cheap storage option. In the model, this charge has been included within the wharfage charge.

Facility or Capital Charge

If cargo requires specialized storage or handling equipment then it is normal for ports to recover these charges by applying, at minimum, its weighted average cost of capital (WACC) to the provided facilities over their economic life and charge against the cargo loaded (on a per tonne basis) or by having a take or pay agreement with the cargo owner on the value of the facilities. (This way the risk is borne by the cargo owner, e.g. if volumes decrease, then the per tonne cost increases).

The model takes into account the marginal infrastructure required at each port to handle coal transhipment operation and prices it accordingly. The equity return is assumed to be 10% which is of 1% above the WACC used by the Queensland Competition Authority in Australia for the Dalrymple Bay Coal Terminal

A case study of the Dalrymple Bay Coal Terminal (2005, August). Retrieved May 2006 from http://www.amc.edu.au/mlm/papers/14

The slight margin is used because of the risks associated both with the coal source and with the transport chain, and the minor scale compared to Australia. However in New Zealand even higher equity returns would be likely to be required. (R. Weaver, CEO Port

Taranaki, personal communication, August 2006). Higher equity returns for port infrastructure would improve the relative financial benefit of the FTS option.

Stevedoring/Marshalling Charge

Most cargo needs to be received at a port and placed into storage and then placed at ship side to be available for loading on to the ship. This process is called marshalling and is normally carried out by a marshalling company and charged quite separately from other described port charges. The process of loading the cargo onto the ship is called stevedoring and is carried out by stevedoring companies and, again, charged for separately. It is common for theses charges to be calculated on a per tonne basis.

In the case of coal, and for the sake of this model, it is assumed, because the operation is homogenous, that the two charges described (marshalling and stevedoring) are bundled and charged as a handling charge on a per tonne basis. The rate the model uses ($2-76) is a commercial rate most likely to be struck for a volume of 1.3 million tonnes per annum. (G. McNaught, General Manager Stevedoring and Logistics, Toll Owens; personal communication November 2005)

Marine Charges

Ports charge arriving ships for providing services (pilotage and towage) as well as fees that relate directly for the provision of navigational aids, buoys, beacons, dredged channels and radio services. Typically these charges are split into two - a port access charge and a daily service charge for each day the ship is in port. The daily service charge also recovers costs involved with the maintenance of the berth and the "opportunity cost" of the berth being occupied based on the capacity of the berth to generate income. There are usually other miscellaneous charges, e.g. for the supply of water, removal of garbage, the disposal of quarantine garbage, supply of gangways or a night watchman. The charges are normally calculated on a gross registered tonne (g.r.t.) basis and the tariff rates from the web sites of each of the port alternatives have been used. These costs are then converted to a cost per tonne basis.

Because the coal will be being sold on a FOB basis then the buyer of the coal will effectively meet the port costs through the freight rate. As it is most likely that the ships being used will be chartered then it would be unlikely that the buyer could leverage ports into accepting charges lower than tariff, hence there is no deduction for multiple use of the port.

FTS Charges

The port cost charge in the model is based on two things; firstly an exchange rate of NZ$1-00 equals US$0.61, and secondly, indicative rates (in US dollars) provided by Coeclerici for a throughput volume of 1 to 1.5 million tonnes of coal per annum. At 1 million tonnes and below it would be a take or pay agreement based on US $7 per tonne. Increased volumes would result in lower charges per tonne. Appendix I shows that the charge is highly sensitive to exchange rate movements. The $US/NZ rate drop from 0.7 to 0.5 increases the per tonne price by $3.59 which makes it about the same cost as barging to the next cheapest alternative, New Plymouth, setting aside the increase in fuel prices for the barging option due to exchange rate drop.

Sensitivity analysis.

All of the transport options and associated costs are sensitive, to varying degrees, to various inputs. All of the options are sensitive to Fuel price changes. The least sensitive to fuel is the FTS option. The table below shows the increased cost ($) per tonne for a percentage fuel increase from the base of $0.80 per litre.

Table 1: Per tonne cost increase with Fuel cost escalation.

	Fuel as a Percentage of cost	10% Increase Fuel	20% Increase Fuel	50% Increase Fuel	100% Increase Fuel
FTS	20%	$0.16	$0.31	$0.79	$1.57
Port Kembla	26%	$1.02	$2.04	$5.10	$10.2
Picton	22%	$0.26	$0.51	$1.28	$2.55
Marsden Pt	25%	$0.62	$1.24	$3.10	$6.19
New Plymouth	21%	$0.24	$0.48	$1.19	$2.38
Tauranga	25%	$0.69	$1.38	$3.45	$6.90
Wellington	23%	$0.27	$0.55	$1.37	$2.73
Road	22%	$4.00	$8.00	$20.00	$40.00
Rail	10%	$1.66	$3.32	$8.30	$16.60

Any fuel price increase works in favour of the FTS option.

An item the FTS is highly sensitive to, the exchange rate, can be compared with the option of barging to New Plymouth (which PRCC has chosen as its transport option). The rate to which the NZ dollar must fall against the US to make the choice neutral can be calculated. As the exchange rate falls, the fuel price will increase (fuel prices internationally set in $US) and this needs to be factored in. The differential in costs per tonne between the FTS and New Plymouth, due to fuel price changes needs to be subtracted off the negative affect of the exchange rate change (because the FTS option is always advantaged by fuel price increases). Note - where there is an appreciation of the NZ $ against the US$ the opposite needs to occur.

Table 2: Per tonne cost change due to exchange rate variation.

	NZ$1.00 equals US$0.70	NZ$1.00 equals US$0.60	NZ$1.00 equals US$0.50	NZ$1.00 equals US$0.40
Cost advantage FTS (NZ$1 = US$0.6) over New Plymouth	$4.49	$4.49	$4.49	$4.49
Change in Cost advantage due exchange Rate movement	+$1.38	$0.00	-$1.93	-$4.83
Sub total	$5.87	$4.49	$2.56	-$0.34
Add Fuel differential	-$0.11	$0.00	+$0.16	+$0.41
Final Cost advantage per tonne for FTS.	$5.76	$4.49	$2.72	$0.07

Thus the NZ$ would have to fall below US$0.40 before the FTS was not a viable economic alternative to the tranship option through New Plymouth.

The other area of major sensitivity is the volumes relied upon to recover fixed costs for different options. Using the spreadsheet, different volumes can be input with the results summarised in table 3. As volume decreases, per unit cost increases, which is intuitive as fixed costs are recouped with a smaller volume therefore average fixed cost increases. Of interest is the fact that the New Plymouth option is financially more attractive when volume reduces from 1.3 million tonnes to 1.1 million tonnes. This is because there is a saving on barging costs (The 10,000 tonne barge can be replaced with a 6,000 tonne barge).

Table 3: Cost per tonne with volume variation.

Annual Volume (tonnes)	FTS	New Plymouth	Road	Rail	Jetty
1,300,000	$23.97	$28.46	$47.28	$27.17	$29.70
1,100,000	$25.01	$28.36	$47.78	$27.67	$35.16
900,000	$26.86	$29.99	$48.64	$28.53	$41.93
700,000	$32.20	$32.12	$50.03	$29.92	$52.57
500,000	$39.29	$38.55	$52.53	$32.42	$71.71

The Jetty option (20 year depreciation) can never be competitive, nor the road option. When volumes reach 700,000 tonnes per annum it is neutral between New Plymouth and the FTS. The main increase in cost for the FTS option is that when volumes are 1 million tonnes or less per annum the charge is set at US$7 million, i.e. it is a take or pay agreement. In addition, if volumes go much below 900,000 tonnes per annum then the rail option becomes cheaper. If the exchange rate dropped to NZ$1 equals US$0.50 the advantage of the FTS over New Plymouth drops to $2.72. This advantage would be neutralised with a volume drop to below 900,000 tonnes. The rail cost, however, would increase by $3.32 as fuel increased due to the exchange rate drop.

Chapter Twelve

Research Conclusion

The conclusion from the analysis and the first order costings is that barging coal off the West Coast of the South Island to a floating transfer station is an economically viable alternative to either barging to other intermediate ports or to the use of rail or road through the Port of Lyttelton, or to the building of a specialized deep water jetty. The next cheapest option would appear to be the Jetty option. However, financial advantages aside, there would appear to be severe operational constraints on such a project, not taking into account the time to build the jetty. The other requirement is that the mine life be at least 50 years to get the maximum amortised value of the jetty. Based on a 20 year mine life only, then the cost per tonne advantage of the FTS option increases from $0.66 to $5.74. The NPV (at a discount rate of 10% over the life of the mine) of the cost savings of the FTS over the 20 year jetty option is $63 million. The Jetty and roading options are highly sensitive to volumes and cannot compete with barging to either a FTS or New Plymouth or the rail option.

The following table summarises the financial advantages. (Assuming fuel at $0.8 per litre and $US0.61 equals $NZ1.00 and a volume of 1,300,000 tonnes per annum).

Table 4: Cost per tonne of transport options with per tonne advantage to FTS.

	Cost per tonne	Additional Cost per tonne over FTS.	% Increase	NPV of additional cost 10% discount.
FTS	$23.97			
Tranship New Plymouth	$28.45	$4.48	19%	$49 Million
Road	$47.28	$23.31	97%	$258 Million
Rail	$27.17	$3.20	13%	$35 Million
Jetty 50 year depreciation	$24.63	$0.66	3%	$7 Million
Jetty 20 year depreciation	$29.70	$5.74	24%	$63 Million

The reason the "Jetty 20 year depreciation" option is the relevant option to compare with the FTS option is that the coal reserves at Stockton are 16 million tonnes with a further 5 million tonnes to come from the Cyprus mine.
Solid Energy (2005). Annual Report, page 22.
The reserve is not enough to rely on being able to amortise the Jetty over 50 years.

Should Capesize vessels ever be required to ship West Coast coal, using a FTS is the only option available to do so.

Threats

The threats to barging to a FTS as a viable transport option are:

1) Rail capacity being substantially lifted to cater for full potential production. This is unlikely as it would require capacity to be lifted 300% and the main restriction is the Otira tunnel. Upgrading the rail link and the work needed to be done on the Otira tunnel is likely to cost substantially more than providing an alternative barging link. In addition it exposes the coal exporters to the strategic and commercial risk of having only one transport option. This also presupposes that Lyttelton can (or is willing to) lift its port capacity.
2) Barging transhipment ports being unable to obtain resource consents. This is unlikely as New Plymouth is carrying out coal transhipment presently.
3) A catastrophic event (flooding) at either Westport or Greymouth resulting in the port having to close. Whilst this is possible both ports have been in existence for over 100 years and therefore it is unlikely that both would be affected.
4) Costs keeping Westport or Greymouth open due to heavy dredging requirements making either port un-economic. Whilst both ports experience periods of reduced bar depths (and more recently Westport experienced closure for a month) the harbour entrances at some stage get scoured out by the flood effect of a major run in the river. In addition the dredging capacity of Westport's dredge "Kawatiri" could be increased by physical extension as well as increasing utilisation to deal with such an event.

5) Volume from a mine (or mines) not being able to maintain production at 1 million tonnes per annum.

In conclusion, barging coal to a floating transfer station offers a strategic choice that is financially viable compared to other potential transport options provided the NZ dollar remains at a greater level than US$0.50 and mine production can remain above 1 million tonnes per annum.

Further Research Opportunities

Further research opportunities exist based on the material presented in this dissertation and include the following.

1) Analysis using computer based modelling of the barging to optimise fleet size and stockpile sizes would further refine and confirm operational and cost assumptions in these areas. The NZ engineering firm "Becas" (formerly Beca Carter Holing) have developed a sophisticated computer model called "POLARIS" which could carry out this analysis. Whilst the author has used the software (establishing Container Terminal capacity requirements at Port of Tauranga and barging/stockpile requirements at Port Marlborough for coal), unfortunately the software is a commercial product and costs NZ$25,000 and is beyond the financial scope of the author to use to verify the assumptions used in this dissertation.

2) Further analysis of all of the input assumptions using Monte Carlo simulation (e.g. @ Risk software) would enable a more robust financial model with associated degrees of confidence. This software can be purchased for US$2,500 and was beyond the financial scope of this dissertation.

3) Stockton Coal being barged from Westport and the Buller/Stillwater rail line being closed down. The continued viability of Westport as a commercial port could then be modelled in the event of the cement works being closed down. (Cement provides 90% of the wharfage income for the port).

4) Using barging of coal from either Westport or Greymouth to Port Taranaki as a base cargo, would this be sufficient to revitalise the West Coast ports to the extent that other trades would arise?

5) The establishment, with the co-operation of Port of Lyttelton, Solid Energy and Toll Rail, of what exactly the finite capacity of the present rail/port link is, how much it would cost to accomplish and the time frames involved.

References

A case study of the Dalyrymple Bay Coal Terminal. (2005, August). Retrieved May 26th 2006, from http://www.amc.edu.au/mlm/papers/14.

Buller Coal Jetty Review (2003, October), KPMG.

Buller Gorge, (2004, 10th July) Article re state of Midland Line, *Christchurch Press.*

Bulkwayuu, (2005, June) Article on the Bulkwayuu as a floating transfer station, *Latin American supplement, Cargo Systems magazine.*

Carrier glut hits shipping revenue, (2006, January 17th), *New Zealand Herald*, page 1 Business news.

Can Infrastructure keep up with coal demand? (2005). *Bulk Materials International,* March/April 2005.

Centreport. www.centreport.co.nz/centreport/tariffs/34.

Coal Line Cash Worry. (2004, 26th July). *Dominion Post.*

Coal Fact sheets: retrieved June 2005 from www.crownminerals.govt.nz/coal/facts/resource.html.

Coal fired Electricity, (2004, 4th September) Business Article Coal fired electricity-the future is clean, *The Economist.*

Coal Jetty Consents granted (1998), *New Zealand Mining*, Volume 23, page 7-8.

Coal Transport (2005), Solid Energy. *Annual Report 2005*, page 26.

Coal Transport deal. (2004, 29th October). Article re Solid Energy and Toll rail, *Dominion Post.*

Coal upgrade facility complete. (2004, April 16th). Retrieved July 8th 2005, from http:www.lpc.co.nz/Tempfiles/tempDocuments/Media%20releases/2004-04-16%/20Coal%upgrade.pdf.

Cole, Malcolm. (2005, 5th October). "*The Courier Mail*" (Australia).

Elder, Don. CEO Solid Energy. (2005, 15th February). Article re Midland Line and use of Barges for coal, *Dominion Post.*

Elder, Don. CEO Solid Energy. (2004, 26th July). Coal ships to transport West Coast Coal. *Dominion Post.*

De Lacy, Hugh. (2004). Elder: Co-operation option for Coast Coal transport. Page 14 "*Contractor*", NZ Quarrying and Mining, March, 2004.

FTS, (2004, May/June). Article on Floating Transfer stations, *Bulk Material International,* Pg 6.

FutureGen, (2005) Article from the Energy data file retrieved October 2005 from http://www.med.govt.nz/upload/28709/2005021.pdf.

Grey district coal export forecast: planned and prospective Production. Port of Greymouth Ltd.

Harbour Quays, Centreport launches Business Park. (2005, July 14th). Retrieved 28th June, 2006 from http://www.centreport.co.nz/centreport/166.html.

Humphreys, Lyn, & Maetzig, Rob. (2005, December 24th). Port Taranaki wins $80 million coal contract. *Taranaki Daily News*, page 1.

Kellog Brown & Root Pty Ltd. (2004, June 22). *Review of the South Island Rail Coal route.* Retrieved 7th July, 2006, from http:// www.landtransport.govt.nz/rail/coal-route.pdf.

Kellog Brown and Root. (2004, 24th June). Article on the Midland Line, *Marlborough Express.*

McDouall Stuart. (2005, November 24th). *Equity research NZ Oil and Gas Ltd.* Retrieved July 22, 2006, from http://www.nzog.net/Investorsection/NZOG/20Report%2024Nov05.pdf.

Madgwick, P. (2004, November 13th). King Coal Rocks, *Christchurch Press*

Madgwick, P. (2004, May 4th). Coalmine progress exciting, *Christchurch Press.*

Madgwick, P. (2004, 10th July). Extra Coal Train, *Christchurch Press.*

Maiello, Dr Domenico (2002, 18/19th November). '*International Coal Trade and Price developments in 2002"* presentation to the United Nations Economic and Social Council, twelfth session, Geneva.

Maiello, Dr Domenico(2004, 7/8th December). "*Coal in Sustainable Development*" Presentation to the United Nations Economic Commission, seventh session, Geneva.

Midland Line, (2004, November 3rd). *Christchurch Press.*

Miner goes for barge alternative. (2004, November 3rd). *Christchurch Press.*

Morgan, Stanley. (2005, March/April). Can infrastructure keep up with coal Demands. *Bulk Materials International.*

Moynihan, Steve. (2003). "Optimising Infrastructure and Ship size for a river port" paper delivered to the "*Coasts and Ports Australasian Conference 2003*".

New Zealand Nautical Almanac 1999. Land Information New Zealand, Crown copyright 1998.

Odea, Pat (2004, 26th July). *Dominion Post.*

Pettigrew, Bobby (2005). Event report, Otira Tunnel site visit. [Abstract]. IPENZ West Coast branch. Retrieved 20th August 2006, from http://www.ipenz.org.nz/westcoast/docs/Eent-Report050618.pdf.

Pike River Coal Company (26th March 2004) Christchurch Press.

Pike River Coal Company (2005, 24th December) Article re $80 million contract for coal Transport, *Taranaki Daily News,* page 1.

Port Kembla. www.kemblaport.com.au/system/files//f2/069/port%20charges%.pdf.

Port of Lyttelton. www.lpc.co.nz/tempfiles/tempdocuments/other/2006%20lpc%20pricing0%20visit.pdf.

Port Marlborough. www.portmarlborough.co.nz/IM_custom/contentstore/assetts/5/64/6785125d...pdf.

Port Taranaki. www.porttaranaki.co.nz/general/documents/tariffs_20050701b.pdf.

Port of Tauranga. www.port-tauranga.co.nz/shipping_information_charges.

Port Taranaki, (2006). *Portal*, page 6. New Plymouth, New Zealand: Port Taranaki.

Price Waterhouse Coopers. (2004, January). Infrastructure Stocktake (Rail). Report for the Ministry of Economic Development, January 2004. Available at http://www. Med.govt.nz/upload/17774/pwc_audit.pdf.

Price Waterhouse Coopers. (2004, June 30th). The Cost of Capital Report. Retrieved July 7th 2006, from http://www.pwcglobal.com/nz/eng/ins-sol/publications/Cost_of_Capital_jun_04.pdf).

Rail Investment, (2004, 26th July) Article re $25 million Investment in Midland Line. *Dominion Post.*

Rail deferred maintenance. (2004, 25th August). *Christchurch Press.*

Record Solid Energy Volumes. (2006, April 29th). The Shipping Gazette, p.19.

Sea Terminals Ltd, (2006). Coal Trans-shipment Facility Golden Bay, New Zealand. Assessment of Environmental Effects.

Solid Energy Annual Report (2005).

Solid Energy. (March 2004). *"Contractor",* New Zealand Quarrying and Mining.

Terenzio, Mario. Floating Terminals: A Logistics Solution in the Dry-Bulk Trade_Coal Handling in the lake of Maracaibo. Retrieved from http://www.porttechnology.org/journals/ed11/section.06.shtml.

West Coast coal export Forecast: 1995-2025. Port of Greymouth Management Ltd.

Williams, Keith (2004, 10th November). Coking coal price, *Dominion Post.*

Appendix 1

Port	Distance From Grey nautical miles	Coal(tonnes) Yearly Production	Required Delivery Rate (per week)	Barge Steaming time (Hours)	Average time Delay (Hours)	Trips per week	Barge Capacity required	Barge 1	Barge 2	Barge 3	Barge 4	Barge 5	Barge 6	Total Capacity(tonnes dwt)	
FTS	165	1300000	25000	47.1	12.3	2.17	11528	6000	6000					12000	FTS
Kembla(Aust)	1071	1300000	25000	306.0	33.3	0.46	54218	10000	10000	10000	10000	8000	8000	56000	Kembla(Aust)
Picton	268	1300000	25000	76.6	14.7	1.46	17156	10000	8000					18000	Picton
Marsden Pt	650	1300000	25000	185.7	23.6	0.72	34716	10000	10000	8000	8000			36000	Marsden Pt
New Plymouth	251	1300000	25000	71.7	14.3	1.53	16375	10000	8000					18000	New Plymouth
Tauranga	725	1300000	25000	207.1	25.3	0.65	38462	10000	10000	10000	10000			40000	Tauranga
Wellington	287	1300000	25000	82.0	15.2	1.39	18030	10000	8000					18000	Wellington

Possible Barge Configuration to meet Capacity Requirement (Barge 1 – Barge 6)

Average Steaming Speed(knots): 7

Barge Size	Capital Cost per Year	Variable Cost	Total per annum	per tonne
10000 tonne	$ 3,934,426	$ 2,683,607	$ 6,618,033	661.80
8000 tonne	$ 2,990,164	$ 2,357,541	$ 5,347,705	668.46
6000 tonne	$ 2,045,902	$ 2,041,475	$ 4,087,377	681.23

# of Barges per port option	Barge Size 10000	8000	6000	Costs(fixed + Var)	Fuel	Total	Tonnes	Cost per tonne
				Barging Costs per tonne per Port option				
FTS			2	$ 8,174,754	$ 2,041,000	$ 10,215,754	1,300,000	$ 7.86
Kembla(Aust)	4	2		$ 37,167,541	$ 13,260,000	$ 50,427,541	1,300,000	$ 38.79
Picton	1	1		$ 11,965,738	$ 3,319,333	$ 15,285,071	1,300,000	$ 11.76
Marsden Pt	2	2		$ 23,931,475	$ 8,047,000	$ 31,978,475	1,300,000	$ 24.60
New Plymouth	1	1		$ 11,965,738	$ 3,094,000	$ 15,059,738	1,300,000	$ 11.58
Tauranga	4			$ 26,472,131	$ 8,974,333	$ 35,446,464	1,300,000	$ 27.27
Wellington	1	1		$ 11,965,738	$ 3,553,333	$ 15,519,071	1,300,000	$ 11.94

Total Charge per tonne	**Barge cost**	**Port Cost** Panamax	Capesize	**Saving Ocean Freight.** Panamax	Capesize	**Total Costs FOB** Panamax	Capesize
FTS	$ 7.86	$ **10.11**	$ **11.51**	$ -	0	$ 17.97	$ 19.37
Kembla(Aust)	$ 38.79	$ 2.26	$ 2.43	$ 0.99	$ 0.81	$ 42.04	$ 42.03
Picton	$ 11.76	$ 10.44	$ 17.73	-$ 0.13	-$ 0.11	$ 22.07	$ 29.38
Marsden Pt	$ 24.60	$ 8.05	na	$ 0.78	na	$ 33.43	na
New Plymouth	$ 11.58	$ 10.62	na	$ 0.24	na	$ 22.45	na
Tauranga	$ 27.27	$ 8.95	na	$ 0.45	na	$ 36.67	na
Wellington	$ 11.94	$ 8.75	na	-$ 0.18	na	$ 20.51	na

Cost advantage of the FTS over other Barging options on a per tonne basis (Panamax loads).

	Picton	New Plymouth	Wellington	Marsden Point	Tauranga	Port Kembla
FTS	**$ 4.10**	**$ 4.49**	**$ 2.54**	**$ 15.47**	**$ 18.71**	**$ 24.07**

Cost advantage of the FTS over other Barging options on a per tonne basis (Capesize loads).

	Picton	Port Kembla
FTS	**$ 10.01**	**$ 22.66**

Note Picton is Shakespeare Bay

Appendix II

Barge Costs Calculation

	Costs US$	$0.61	Depn 5%	Finance @ 7%	Equity Return 12%	Total Capex Charge per an	Capex factor
10000 tonne Barge	$ 10,000,000	$ 16,393,443	$ 819,672	$ 1,147,541	$ 1,967,213	$ 3,934,426	100%
8000 tonne Barge	$ 7,600,000	$ 12,459,016	$ 622,951	$ 872,131	$ 1,495,082	$ 2,990,164	100%
6000 tonne Barge	$ 5,200,000	$ 8,524,590	$ 426,230	$ 596,721	$ 1,022,951	$ 2,045,902	100%

Variable costs per annum

Barge	10000 tonne	Assumptions	
	Insurance	2% Capital Cost	$ 327,869
	Salary	5 Men crew time on/time off (10 men @ 65k + 20%)	$ 780,000
	R&M	4% Capital Cost. (including docking provision)	$ 655,738
	Sundry	(including 15% Admin profit)	$ 920,000
		Total	$ 2,683,607
Barge	8000 tonne	Assumptions	
	Insurance	2% Capital Cost	249,180.33
	Salary	5 Men crew time on/time off (10 men @ 65k + 20%)	$ 780,000
	R&M	4% Capital Cost. (including docking provision)	498,360.66
	Sundry	(including 15% Admin profit)	$ 830,000
		Total	$ 2,357,541
Barge	6000 tonne	Assumptions	
	Insurance	2% Capital Cost	170,491.80
	Salary	5 Men crew time on/time off (10 men @ 65k + 20%)	$ 780,000
	R&M	4% Capital Cost. (including docking provision)	340,983.61
	Sundry	(including 15% Admin profit)	$ 750,000
		Total	$ 2,041,475

Fuel Calc Usage

Barge Size	Daily use	Per Hour liters	Cost fuel NZ $ 0.80	Cost per mile
10000	10 tonne	417	$ 333.33	$ 47.62
8000	8 tonne	333	$ 266.67	$ 38.10
6000	6 tonne	250	$ 200.00	$ 28.57

	Average Time per trip Hours	Maximum Trips per annum	Miles per round trip	Number of Barges	Miles per Year per Barge	Total Miles per Port option	Steaming Time	Steaming Hours per annum	Required Trips per annum
FTS	56.6	155	330	2	35750	71500	47.1	5103	108
Kembla(Aust)	342.9	26	2142	6	49725	298350	306.0	7104	23
Picton	94.3	93	536	2	38711	77422	76.6	5532	72
Marsden Pt	222.9	39	1300	4	46944	187778	185.7	6706	36
New Plymouth	85.7	102	502	2	36256	72511	71.4	5157	72
Tauranga	274.3	32	1450	5	47125	235625	207.1	6731	33
Wellington	101.1	87	574	3	41456	124367	82.0	5922	72

Annual Cost per Annum Fuel

	10,000 tonne	8,000 tonne	6000 tonne
FTS	$ 1,700,833	$ 1,360,667	$ 1,020,500
Kembla(Aust)	$ 2,367,857	$ 1,894,286	$ 1,420,714
Picton	$ 1,844,074	$ 1,475,259	$ 1,106,444
Marsden Pt	$ 2,235,278	$ 1,788,222	$ 1,341,167
New Plymouth	$ 1,718,889	$ 1,375,111	$ 1,031,333
Tauranga	$ 2,243,583	$ 1,794,867	$ 1,346,150
Wellington	$ 1,974,074	$ 1,579,259	$ 1,184,444

Appendix III

WEST COAST COAL BARGING -trip time with delay calculations

Port	*Distance* (nautical miles)	*Round trip* *(two x dist)*	*Sail Time* (hours)	*Mean Storm*	*Max Storm*	*Mean Time*	*Max Time*	*Tide Wait*	*Mean Delays*	*% Delays*	*Mean Trip* **time (hours)**
FTS	166	330	47.1	6.6	10.8	51.0	53.4	8.5	12.3	26.2	59.5
Kembla	1071	2142	306.0	42.8	70.4	330.8	346.8	8.5	33.3	10.9	339.3
Picton	268	536	76.6	10.7	17.6	82.8	86.8	8.5	14.7	19.2	91.3
Marsden Pt	650	1300	185.7	26.0	42.7	200.8	210.5	8.5	23.6	12.7	209.3
New Plymouth	251	502	71.7	10.0	16.5	77.5	81.3	8.5	14.3	20.0	86.0
Tauranga	725	1450	207.1	29.0	47.6	224.0	234.8	8.5	25.3	12.2	232.5
Wellington	287	574	82.0	11.5	18.9	88.7	92.9	8.5	15.2	18.5	97.2
									Average	$\boxed{17.1}$	

Average Speed	**7.0**	knots		
Annual Volume	**1,300,000**	tonnes		
Max Ship Capacity	**60,000**	tonnes		
Visits	**22**	per year		
Average export shipment	**59,100**	tonnes		
Visit frequency	**16.6**	days	398	hours
Ship port time	**2.9**	days	70	
Inter-visit time	**13.7**	days	329	

Coal Ships Arrivals	*Start*	*End*	*Mid*	*Range*	*Prob*	
Early Arrival	256	280	268	24	0.05	13.4
Scheduled	280	352	316	72	0.85	268.6
Late Arrival	352	568	460	216	0.10	46.0
Target mean	328				1.00	328.0

Storms	*No. Events*		*Duration*		*Low*	*Mean*	*High*
	10	12	0.33	1	3.3	7.7	12.0
	5	7	1	3	5.0	13.0	21.0
	2	3	2	8	4.0	14.0	24.0
	1	2	8	12	8.0	16.0	24.0
			Storm-Days		20.3	50.7	81.0
			Storm-Hours		487.2	1215.6	1944.0
			Percent		**0.06**	**0.14**	**0.23**

Speed in storm	3	knots
Relative speed	**0.42**	

Tidal period	12.5	hours
Tide window empty	6.0	hours
Tide window loaded	2.0	hours
Closed	6.5	hours
Closed	10.5	hours
Average wait empty	3.25	hours
Average wait full	5.25	hours
Average wait trip	**8.5**	hours

Barge Size	10000 tonne		8000 tonne	6000 tonne
Main Port				
Sea to berth	0.5	hour	0.5	0.5
Pre-load	0.5	hour	0.5	0.5
UnLoad (900 tph)	11.1	hour	8.9	6.7
Post load	0.5	hour	0.5	0.5
Berth to sea	0.5	hour	0.5	0.5
West Coast				
Sea to berth	0.5	hour	0.5	0.5
Pre-load	0.5	hour	0.5	0.5
Load (1000 tph)	10	hour	8	6
Post load	0.5	hour	0.5	0.5
Berth to sea	1	hour	1	1
Port Time	**25.6**		**21.4**	**17.2**
Allow	**26 Hours**		**22 Hours**	**18 Hours**

Appendix IV

Ocean Freight Saving Calculation.

Note: **FTS at Golden Bay is Datum**

	Panamax Rate/day		Capesize Rate/day
US$	$ 21,742.00	**US$**	$ 35,643.00
NZ$	$ 35,642.62	**NZ$**	$ 58,431.15

Exchange Rate: 0.61

Load Size		
Panamax	72,000	tonnes
Cape Size	145,000	tonnes

Port	Distance closer to market(Asia)	Hrs Steaming (15knts)	Days Saved	Cost Saved Panamax	Capesize	Rate per Tonne Panamax	Rate per Tonne Capesize
Kembla(Aust)	360.00	**24.00**	2.000	$ 71,285.25	$ 116,862.30	$ 0.99	$ 0.81
Picton	-47.00	**-3.13**	-0.261	-$ 9,306.68	-$ 15,257.02	-$ 0.13	-$ 0.11
Marsden Pt	285.00	**19.00**	1.583	$ 56,434.15	$ 92,515.98	$ 0.78	$ 0.64
New Plymouth	89.00	**5.93**	0.494	$ 17,623.30	$ 28,890.96	$ 0.24	$ 0.20
Tauranga	165.00	**11.00**	0.917	$ 32,672.40	$ 53,561.89	$ 0.45	$ 0.37
Wellington	-67.00	**-4.47**	-0.372	-$ 13,266.98	-$ 21,749.37	-$ 0.18	-$ 0.15

Distance Table **(Nautical Miles)**	To Asia
FTS	5136
Lyttelton	5345
Picton	5183
Kembla	4776
Marsden Pt	4851
New Plymouth	5047
Tauranga	4971
Wellington	5203
Picton/Kembla/Asia	5437

Appendix V
Port Cost Calculations

Throughput (tonnes)	1,300,000	Wharfage Multiplier	90%

Port	Wharfage	Handling Charge Panamax	Handling Charge Cape Size	Capital Charge Panamax	Capital Charge Cape Size	Marine Charges Panamax	Marine Charges Cape Size	Tug Charges Panamax	Tug Charges Cape	Total Charge per tonne Panamax	Total Charge per tonne Cape
FTS	$ -	$ 9.51	$ 9.51	$ -	$ -	$ -	$ -	0.6	2	$ 10.11	$ 11.51
Kembla(Aust)	$ 0.74	$ 1.20	$ 1.20	$ -	$ -	$ 0.39	$ 0.49	0	0	$ 2.26	$ 2.43
Picton	$ 3.80	$ 2.76	$ 2.76	$ 2.55	$ 6.89	$ 0.41	$ 0.48	1.3	3.8	$ 10.44	$ 17.73
Marsden Pt	$ 3.50	$ 2.76	na	$ 1.60	na	$ 0.54	na		na	$ 8.05	
New Plymouth	$ 3.98	$ 2.76	na	$ 3.59	na	$ 0.69	na		na	$ 10.62	
Tauranga	$ 5.52	$ 2.76	na	$ 0.68	na	$ 0.54	na		na	$ 8.95	
Wellington	$ 3.30	$ 2.76	na	$ 2.52	na	$ 0.50	na		na	$ 8.75	

Panamax Load size (tonnes) 50000 — Days in Port 2

Marine Charges	Ship Visits	Av V/l size(GRT)	Port Access	Daily Charge	Total Charge	Per tonne
FTS	26	30000	0.00	0.00	$ -	$ -
Kembla(Aust)	26	30000	0.25	0.20	$ 507,000	$ 0.39
Picton	26	30000	0.38	0.15	$ 530,400	$ 0.41
Marsden Pt	26	30000	0.70	0.10	$ 702,000	$ 0.54
New Plymouth	26	30000	0.85	0.15	$ 897,000	$ 0.69
Tauranga	26	30000	0.70	0.10	$ 702,000	$ 0.54
Wellington	26	30000	0.70	0.07	$ 655,200	$ 0.50

Cape Size Load size (tonnes) 130000 — Days in Port 3

Marine Charges	Ship Visits	Av V/l size(GRT)	Port Access	Daily Charge	Total Charge	Per tonne
FTS	10	75000	0	0	$ -	$ -
Kembla(Aust)	10	75000	0.25	0.2	$ 637,500	$ 0.49
Picton	10	75000	0.38	0.15	$ 622,500	$ 0.48
Marsden Pt	10	75000	0.7	0.1	$ 750,000	$ 0.58
New Plymouth	10	75000	0.7	0.1	$ 750,000	$ 0.58
Tauranga	10	75000	0.7	0.1	$ 750,000	$ 0.58
Wellington	10	75000	0.7	0.1	$ 750,000	$ 0.58

Capital Expenditure Panamax

	Stockpile (plus civil works)	Barge Berth	Conveyors Discharge	Conveyors Stockpile	Conveyors Reclaim	Shiploader	Dredging	Wharf	Total	Capex Multiplier
FTS	$ -	$ -	$ -	$ -	$ -	$ -	$ -		$ -	100%
Kembla(Aust)	$ -	$ -	$ -	$ -	$ -	$ -	$ -		$ -	100%
Picton	$ 7,300,000	$ 1,000,000	$ 1,500,000	$ 2,400,000	$ 800,000	$ 750,000	$ -	$ 1,000,000	$ 14,750,000	100%
Marsden Pt	$ 1,000,000	$ 1,800,000	$ 1,500,000	$ 2,400,000	$ 800,000	$ 750,000	$ -	$ 1,000,000	$ 9,250,000	100%
New Plymouth	$ 1,000,000	$ 1,800,000	$ 1,500,000	$ 2,400,000	$ 800,000	$ 750,000	$ 12,500,000		$ 20,750,000	100%
Tauranga				$ 2,400,000	$ 800,000	$ 750,000	$ -		$ 3,950,000	100%
Wellington	$ 7,300,000	$ 1,800,000	$ 1,500,000	$ 2,400,000	$ 800,000	$ 750,000	$ -		$ 14,550,000	100%

Capital Expenditure Cape Size

	Stockpile	Barge Berth	Conveyors Discharge	Conveyors Stockpile	Conveyors Reclaim	Shiploader	Dredging	Wharf	Total
FTS	$ -	$ -	$ -	$ -	$ -	$ -	$ -		$ -
Kembla(Aust)	$ -	$ -	$ -	$ -	$ -	$ -	$ -		$ -
Picton	$ 13,000,000	$ 1,800,000	$ 2,500,000	$ 3,000,000	$ 2,500,000	$ 4,500,000	$ 2,000,000	$ 10,500,000	$ 39,800,000

Capital Charge	%
Depn	5%
Opex	2%
R&M	5%
Ins	1%
Equity Return	10%
Total%	23%

Note-Equity return set high as port exposed to mining risk

Appendix VI

Rail Transport Option

Base Rail rate	0.07
Fuel as Percent of Total cost	10%
Base Fuel price	0.8
Varied Fuel price	0.8
Fuel varied rail rate per TKM	0.07

Volume tonnes coal	1300000	Cost Rail Transport cents per tonne/ KM		0.07
Train Size (tonnes)	1500			
No of trains per annum	867	Trip Distance	238.2 km's	
No of trains per week	17			

Cost per tonne $ 16.67

Plus Lyttelton Port Charges

	Low	High		
Wharfage charge	$2.50	$3.90	assume	$3.00
Coal Facility charge	$3.00	$4.00	assume	$3.50
Stevedoring/loader charge	$3.75	$5.00	assume	$4.00
Total Cost Port Lyttelton	$9.25	$12.90		$10.50

Total of Rail charge plus Port Lyttelton charge $ 27.17

Greymouth Option FTS	$ 17.97
Plus Port Grey Charge (Likely)	$ 6.00
Total Grey-FTS	$ 23.97

Advantage of Grey-FTS option over Rail transport **$ 3.21** per tonne

Coal Handling Facility charge per tonne

Note Capex		$35,000,000	Note: Publicly reported
Dep	5%	$1,750,000	
Opex	2%	$700,000	
Ins	1%	$350,000	
Return	12%	$4,200,000	
Maintenance	5%	$1,750,000	
Total per annum		$8,750,000	
50% to Solid Energy		$4,375,000	Note: This assumption made on the basis Solid Energy has a stake in the Coal Handling Facilities and would extract a premium from Port Lyttelton which would be passed on to third party user
Capex Charge		$4,375,000	
per tonne based on	1300000	$3.37	

Appendix VII

Road Cost Calculation

Road Distance Greymouth to Lyttelton.	265	
Truck Capacity (tonnes)	25	
Volume of Coal (tonnes per annum)	1300000	Distance Table (Kilometre's)
No of Truck trips reqd	52000	
Cost per tonne/kilometer	$ 0.15	
Round trip time (hours)	8	255 Grey-ChCh
Trips per annum	730	10 ChCh-Lyt
Total trucks reqd	71	**265 Total**
Cost per tonne (trucking)	$ 40.08	
Lyttelton Port Costs	$ 7.20	
Total Cost Road Option	$ 47.28	
Greymouth Option FTS	$ 17.97	
Plus Port Grey Charge (Likely)	$ 6.00	
Total Grey-FTS	$ 23.97	
Advantage of Grey-FTS option over Road transport	**$ 23.32**	

Note: Distance Mine to Grey not included as it is similar distance in both Road and Port option

Road Transport Assn Truck Cost Model Output

1 Productivity

	Running	Standing
Hours per Day	17.5	6.5
Day per Week	7	7
Weeks per Year	51	51
Total Hours	6,248	2,321
Annual Kil Truck	406,980	Trailer 406,980

2 Equipment

	Value New	Age Now	Life in Years	Residual
Truck	250,000	0	3	40,000
Trailer	100,000	0	3	15,000

3 Running Costs

		Base Unit	Truck Rate	Truck Cost	Trailer Rate	Trailer Cost	Total
	Fees/Fine:	$	2000	2,000			2,000
.8000 c per l	Fuel	kms	.56 l/km	182,327			182,327
	Rprs & Ma	kms	0.12	48,838	0.07	28,489	77,326
	RUC	kms	0.2419	98,448	0.13	52,907	151,356
	Tyres	kms	0.04	16,279	0.025	10,175	26,454
							439,463

4 Labour Costs

	Base Unit	Truck Rate	Truck Cost	Trailer Rate	Trailer Cost	Total
Wages Ru	Hr	19.08 per hr	119,202			119,202
Wages St	Hr	19.08 per hr	44,275			44,275
Acc	Wages	0.0312	5,100			5,100
						168,578

5 Standing costs

	Base Unit	Truck Rate	Truck Cost	Trailer Rate	Trailer Cost	Total
Depreciati	$ Value		70,000		28,333	98,333
Fleet Com	$	1000	1,000			1,000
Insurance	$ Value	2%	5,000	2%	2,000	7,000
Insurance Excess		2000	2,000	2000	2,000	4,000
Interest or 0% on Cap Valu		9%	11,250	9%	4,500	15,750
Plant Leas	$	8400	8,400			8,400
Drivers Ex	$	35700	35,700			35,700
Protective	$	1500	1,500			1,500
						171,683

6 Administration

	Base Unit	Truck Rate	Truck Cost	Total
Administra	$	20,000	20,000	20,000

7 Ownership Cost

	Base Unit	Truck Rate	Truck Cost	Total
Ownershi	50 % on Value	17.9%	31,325	31,325

Operating Cost	**Total**	831,049	27 tonnes per load
	per hr	96.99	265 km per 1 way trip
	per km	2.042	40.08 dollars per tonne
	Per TKM	0.151259	
Running Costs	**Total**	563,766	
	per km	1.39	
Standing Costs	**Total**	391,586	
	per hr	45.70	
Fuel as Percent of Costs		22%	

Appendix VIII

Jetty Option 1st order costing.

			50 Year Option			20 Year Option		
Capital Cost		$ 220,000,000	Depn (50 years)	2%	$ 4,400,000	Depn (20 years)	5%	$11,000,000
			Capital Charge	10%	$ 22,000,000	Capital Charge	10%	$22,000,000
Coal Volume (tonnes		1,300,000	Total		$ 26,400,000	Total		$33,000,000
Capital charge per tonne					$ 20.31			$ 25.38
Operating costs		$ 8,000,000						
Operating costs per tonne					$ 6.15			$ 6.15
			Total per tonne cost		**$ 26.46**			**$ 31.53**
Greymouth Option FTS		$ 17.97						
Plus Port Charge (Likely)		$ 6.00						
Total Westport-FTS		$ 23.97						
Ist order savings	per tonne basis	**$ 2.50**	Total					**$ 7.57**
Note: Ist order saving Ist order savings			per tonne basis					
added back as Westport 60 miles closer to FTS.								
Adjustment								
Road	30km * $0.15	$ 4.50						
Barging	60 nautical miles	$ 2.67						
	Difference	$ 1.83			$ 24.63			
Ist order savings	per tonne basis	**$2.50**						
less Adjustment difference		$1.83						
Advantage of -FTS option		**$ 0.67**				Advantage of -FTS option		**$ 5.74**
over Jetty Option (per tonne)						over Jetty Option (per tonne)		
50 year depreciation.					50 year depreciation	20 year depreciation.		20 year depreciation.
			Total Cost per tonne.		**$ 24.63**	Total Cost per tonne		**$ 29.70**

Appendix IX
Sensitivity to exchange rate and fuel price variations

Table A

FTS Cost Sensitivity to $NZ/US exchange rate			
Based on volume 1.3 million tonnes		$NZ Cost per tonne	
	Rate	Panamax	Cape Size
	1	$ 5.80	$ 5.80
	0.9	$ 6.44	$ 6.44
Rate $NZ1 = $US	0.8	$ 7.25	$ 7.25
	0.7	$ 8.29	$ 8.29
	0.6	$ 9.67	$ 9.67
	0.5	$ 11.60	$ 11.60
	0.4	$ 14.50	$ 14.50

Table B

Fuel as % of Barging Cost		price change per tonne with % Increase in fuel 10%	20%	50%	100%
20%	FTS	$ 0.16	$ 0.31	$ 0.79	$ 1.57
26%	Kembla(Aust)	$ 1.02	$ 2.04	$ 5.10	$ 10.20
22%	Picton	$ 0.26	$ 0.51	$ 1.28	$ 2.55
25%	Marsden Pt	$ 0.62	$ 1.24	$ 3.10	$ 6.19
21%	New Plymoutl	$ 0.24	$ 0.48	$ 1.19	$ 2.38
25%	Tauranga	$ 0.69	$ 1.38	$ 3.45	$ 6.90
23%	Wellington	$ 0.27	$ 0.55	$ 1.37	$ 2.73
Fuel difference FTS/New (per tonne coal +tve- advantage to FTS)		$ 0.08	$ 0.16	$ 0.41	$ 0.81

Table D

Movement in exchange rate to destroy FTS advantage over New Plymouth					
Exchange Rate $NZ1= $US	0.7	0.6	0.5	0.4	0.38
Increase in per tonne cost	-$ 1.38	$ -	$ 1.93	$ 4.83	5.59
Cost advantage FTS over New I	$ 4.49	$ 4.49	$ 4.49	$ 4.49	$ 4.49
Cost advantage	$ 5.87	$ 4.49	$ 2.55	-$ 0.35	-$ 1.10
Add back Fuel price difference between FTS/New Plymouth	-$ 0.11	$ -	$ 0.16	$ 0.41	$0.63
Cost Advantage to FTS	$ 5.76	$ 4.49	$ 2.71	$ 0.06	-$ 0.47

Table C

Fuel Cost Sensitivity to $NZ/US exchange rate.			
$NZ/$U	Fuel price % change		price change per tonne due fuel cost change due exchange rate
0.7	-14%		$ 0.11
0.6	nil	Datum	$ -
0.5	20%		$ 0.16
0.4	50%		$ 0.41

Note Table A - shows cost per tonne (based on a throughput of 1.3 million tonnes) in $NZ with exchange rate variation.

Table B - shows change in per tonne cost with the % change in fuel price for each barging option. Datum is $NZ1 = $US 0.60 and fuel at $NZ 0.80 per litre. The bottom line shows the differential between the FTS and the New Plymouth options.

Table C - shows the change in price for coal (per tonne) due fuel price changes as a result in movements in the $NZ/$US exchange rate.

Table D - shows the combined effect of the change in fuel costs and the FTS cost per tonne with exchange rate movement. E.g.If the exchange rate moves from $NZ1.00=$US0.60 to $NZ1.00 = $US0.70 (NZ dollar appreciates) then the per tonne cost at the FTS reduces by $NZ1.38.The cost advantage of the FTS over New Plymouth increases from $NZ 4.49 to $NZ 5.87. However the fuel differential of $0.11 cents per tonne works in favour of New Plymouth so the cost advantage is reduced to $5.76. If the $NZ dollar depreciates to $NZ1.00 = $US0.50 then the cost per tonne on the FTS increases by $1.93 and the cost advantage of the FTS over New Plymouth reduces to $2.55. However the increase in fuel price due to the depreciating NZ$ works in favour of the FTS by $0.16 cents per tonne so the cost advantage of the FTS is NZ$2.71